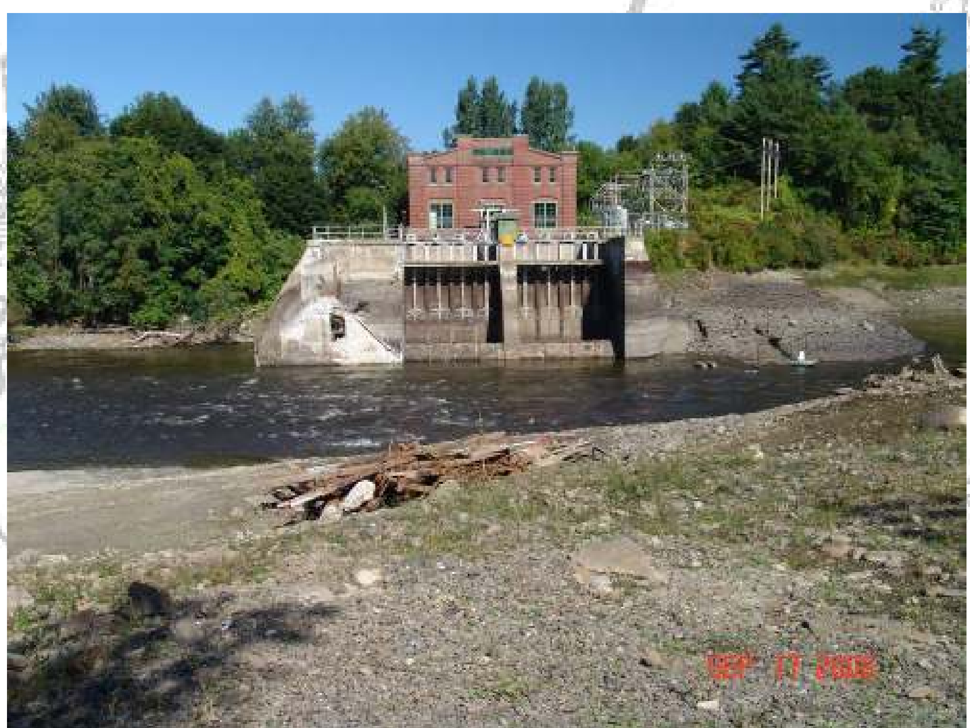
Kennebec River Anadromous Fish Restoration



Annual Progress Report - 2008

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1.0 Executive Summary

On May 8, 2007, the interim Transvac fish pump was installed below the Fort Halifax Hydroelectric Project in Winslow, Maine. Trapping of alewives with the pump began on May 14. The fish pump was shut down on May 25 as escapements numbers were reached. The fish pump collected 401,059 alewives. The total mortality rate of adult alewives sorted by MDMR in 2007 was 0%.

In 2008, All truck stocked river herring were captured at the lockwood Fishlift. The fishlift at the Lockwood dam captured 131, 201 river herring. 93,775 adult river herring were truck stocked out of the Lockwood facility. Additional fish were sluced back into the river below the fishway. A total of 85,022 alewives were also hand bailed over the outlet dam to Webber Pond in Vassalboro, ME.

1.1 Overview

Flashboards at Fort Halifax were installed on May 15, 2008. FPL Energy guidelines for operations personnel and biologists during the herring migration season that state spill over the crest of the dam is to be maintained until FPL biologists safely remove any fish from the ledges to prevent stranding when spill is discontinued. Once the flashboards are installed, the headpond level is to be maintained 0.5 feet below the top of the boards.

The fish pump operated for a total of 12 days (12 fewer than 2007) and an average 33, 422 adult alewives (19,226 in 2007) were collected daily. The higher number of fish collected in 2008 was due to a number of factors including: more favorable environmental conditions compared to 2007, our increased ability to handle larger numbers of fish due to the fish passage upstream, the addition of a counting trough reducing handling time, and the lack of commercial fishing effort due to the commercial harvest closure.

The fish pump collected 401,059 alewives. No fish were transported by truck from Fort Halifax in 2008. All fish were stocked directly into the headpond. Fish pump mortality at Fort Halifax in 2008 was 0.001% This is much lower than in previous years.

The sex ratio of randomly collected alewife samples was 1.0 males: 1.0 females (n=200). Fish lengths and weights decreased over time. The majority of adult alewives collected were age IV males (31%), then age IV females (22%) and age V males (22%).

In 2008 the catch rate at Ft. Halifax wasn't necessarily representative of the run due to various conditions including the delay in the run caused by the inefficiency of the fish pump. Historically (2000-2007), the mean date by which 50% of alewives have been collected is May 18. In 2008, the 50% date of alewife trapping was May 19. The 25% quartile was reached on May 17. The 75% quartile was reached on May 23 (Table 1.1).

The average peak date of alewife pumping (2000-2007) is May 16. In 2008, the peak was on May 17 when 49,330 alewives were collected with the fish pump. The number of mortalities due to handling was very low in 2008.

1.2 Trap, Transport, and Release

MDMR continued to utilize only Kennebec/Sebasticook River adult alewife returns for release into Phase I restoration lakes (Figure 1.1) in 2008. Adult alewives were collected with at the fish lift at the Lockwood Project. The fishlift at the Lockwood dam captured 131, 201 river herring. MDMR personnel transported 9,855 of these river herring to Wesserunsett Lake in Skowhegan and 47,944 river herring above the Shawmut Project. There were also 22,074 river herring stocked in the Sebasticook drainage from Lockwood. There were 13,902 river herring stocked out of basin by MDMR. At the request of MDMR, the remaining 37,426 river herring were returned to the river below the Lockwood Project.

The fish pump at Fort Halifax was configured and operated as in previous years. Briefly, the vacuum chamber and intake hoses were mounted on a platform above the turbine outlets, an 80-foot length of 10-inch diameter discharge pipe extended up the side of the powerhouse from the vacuum chamber to a receiving tank, and the intake pipe terminated in a three-foot long section of 10-inch diameter clear lexan. A chain hoist and ropes allowed the operator some adjustment in the intake apparatus.

The pump lifted and deposited alewives and water into a 2,270-gallon fiberglass receiving tank, measuring 9' x 7'6" x 4'6" deep, located at the top of the dam next to the powerhouse. Oxygen levels were maintained in the tank by a microporous delivery system. Supplemental water was supplied by an electric pump and two-inch hose that discharged onto the surface of the tank. Alewives were either caught in a dip net as they exited the discharge pipe or dip netted from the receiving tank. They were then released into a hopper and sluiced into a counting trough where they were visually counted. They then passed through a large PVC pipe into the headpond. The trough was fed by tank overflow water. The trough was sloped towards the exit pipe where there was an auxiliary water jet to force fish down the pipe. This system was simple and very effective. Special care was taken to insure that only alewives were dipped into the tanks or passed upstream. No carp, white catfish, or northern pike have been captured since the pump was employed at Fort Halifax in 2000.

The stocking trucks are outfitted with pumps to circulate the water in the stocking tanks and with oxygen tanks and a porous pipe delivery system, that introduces approximately six liters of oxygen/minute-1. More complete descriptions of the fish pump, receiving tank, stocking tanks, stocking trucks, associated equipment, and fish handling protocols are provided in previous annual reports and are available from MDMR upon request.

PHASE I RESTORATION

In 2008 all fish captured (401,331) at Ft. Halifax were passed upstream into the headpond. These fish had free passage into Pattee Pond, Plymouth Pond, Burnham Headpond, Unity Pond and Sebasticook Lake. 84,955 alewives were captured in a fish trap at the top of the Sebasticook Lake fishway.

In 2008, 32,171 brood stock river herring were truck stocked into upriver Phase I and II lakes in the Kennebec River watershed (Table 1.2). All of these fish came from the Lockwood Fishlift. Fish were transferred to Douglas Pond (17,699), Wesserunset Lake (9,855), Pleasant Pond (1,117) and Corundal bog (3,500). An additional 37,041 adult alewives were transferred into Shawmut Headpond.

Alewives were also hand bailed over the outlet dam to Webber Pond in Vassalboro, ME. On May 7th, enough alewives had accumulated below the outlet dam to warrant hand bailing. A total of 85,022 alewives were captured between May 7th-23rd at the base of the dam with dipnets and counted into Webber Pond. No alewife mortalities were associated with this effort. Three-Mile Pond was not stocked in 2008, however adult river herring had adequate passage, due to high spring flows, to migrate upstream from Webber Pond (Figure 1.2).

PHASE II RESTORATION

No Phase II lakes were stocked in 2007. MDMR delayed stocking Great Moose Pond until improvements can be made in the down stream passage facility. The discharge of the downstream fish passage facility currently lands on ledge. A plunge pool needs to be constructed or the pipe needs to be extended before alewives are stocked in Great Moose Pond. MDMR continued to focus its efforts on obtaining fish passage in the Pioneer and Waverly dams in Pittsfield. MDMR will start stocking China Lake in 2010 pending approval of the stocking request.

NON-PHASE IN BASIN TRANSFERS

In 2008, non-phase in basin transfers totaled 7,971 river herring. Fish were stocked into Pleasant pond in Gardiner (7,000), and Nehumkeg Pond (971).

OUT OF BASIN TRANSFERS

In 2008, out of basin transfers totaled 13,799 river herring. Fish were stocked into Seal Cove Pond (1,750), Lower Patten Pond (3,498), Webber Pond in Bremen (1,748), Great Pond (2,300), Donnell Pond (2,309), Storer Pond (997), and Tilden Pond (2,196) (Table 1.3).

1.3 Adult Alewife Biosamples Ft Halifax

MDMR personnel sampled 200 adult river herring at Fort Halifax. All samples were collected by dipping them out of the pump-receiving tank. Due to the presence of blueback herring in the Kennebec River, all samples were identified using the guidelines of Liem[1], which distinguishes the two species by body shape, size and position of the eye, and color of the peritoneum (i.e., lining of the gut cavity: alewives are white/silvery and bluebacks are charcoal). Once the fish were identified, they were measured to the nearest millimeter, weighed to the nearest 0.01 grams, sexed and a scale samples were collected for later age analysis. Water temperature was measured to the nearest degree Celsius at the time the sample was collected.

Of the 200 fish collected, identified and measured, 8 fish were identified as a blueback herring. Adult female alewives, 50% of total collected in 2008, were the same length as those collected in 2007 (280 mm). Alewives collected in 2008 were 3.4g heavier (mean = 192.1g) than in 2007 (mean = 188.7g). Adult males, 50% of total collected in 2008, were 1 mm shorter in length (mean = 271 mm) than the 2007 samples (mean = 272 mm) and 4 mm longer than those captured in 2006 (mean = 267mm). They averaged 0.9 g heavier (mean = 167.8g) in 2008 than in 2007 (mean =166.9g).

[1 1] Liem, A.H. 1924. The life history of the shad [Alosa sapidissima (Wilson)] with special reference to the factors limiting its abundance. Contrib. Can. Biol. 2:161-284.

In 2008, there were minor differences in length and weight, both between sexes and over time. On average, females were longer (280 mm) than males (271 mm) and females were heavier (192.1g) than males (167.8g). There was a decrease in both length and weight (Figure 1.3) of adult alewife returns to the Sebasticook River over time.

Of the 200 alewives sampled, scales were collected from 64 fish. Most of the fish sampled were Age 4 (33%) males. 53% of all males were age 4. Age 4 (23%) females and Age 5 males (23%) were the next most abundant age classes. 63% of all females sampled were age 4 (Table 1.4).

1.4 Adult Alewife Biosamples Webber Pond

MDMR personnel sampled 150 adult river herring at Webber Pond. All samples were collected by dipping them out Seven-mile Stream below the outlet dam of the pond. To date no blueback herring have been captured at Webber Pond. Fish were measured to the nearest millimeter, weighed to the nearest 0.01 grams, sexed, and a scale sample was removed for later age analysis. Water temperature was measured to the nearest degree Celsius at the time the sample was collected.

Adult female alewives, 39% of total collected, in 2008 were longer than those collected in 2007. Adult females collected in 2008 were 3 mm longer (mean = 278 mm) than in 2007 (mean = 275 mm). Additionally, those collected in 2008 were 16.9g heavier (mean = 196.9g) than in 2006 (mean = 180.0). Adult males, 61% of total collected in 2008 were 5 mm longer in length (mean = 272 mm) than the 2007 samples (mean = 267 mm). They averaged 18 g heavier (mean = 182.3g) in 2008 than in 2007 (mean =164.3g).

In 2008, there were minor differences in length and weight, both between sexes and over time. On average, females were longer (278 mm) than males (272 mm) and females were heavier (196.9g) than males (182.3g). There was a decrease in both length and weight (Figure 1.4) of adult alewife returns to Webber Pond over time.

Of the 150 alewives sampled, scales were collected from 48 fish. Most of the fish sampled were Age 5 (35%) males. 59% of all males were age 5. Age 5 (21%) females were the next most abundant age classes. 53% of all females sampled were age 5 (Table 1.5).

1.5 Adult Alewife Biosamples Lockwood Fishlift

MDMR personnel sampled 100 adult river herring at the Lockwood fishlift. All samples captured by the fishlift and were collected by netting them out of the facilities holding tanks. Two blueback herring were captured. Fish were measured to the nearest millimeter, weighed to the nearest 0.01 grams, sexed, and a scale sample was removed for later age analysis. Water temperature was measured to the nearest degree Celsius at the time the sample was collected.

Adult female alewives comprised 54% of total collected. Adult females collected in 2008 were an average of 283 mm and weighed an average of 195.9g. Adult males comprised 46% of total collected in 2008. Adult males in 2008 were an average of 264 mm and weighed 159.2g. On average, females were longer (283 mm) than males (264 mm) and females were heavier (195.9g) than males (159.2g).

Of the 100 alewives sampled, scales were collected from 66 fish. Most of the fish sampled were Age 4 (30%) males. 59% of all males were age 4. Age 5 (26%) females were the next most abundant age classes. 53% of all females sampled were age 5 (Table 1.6).

Figure 1.1 Kennebec River Restoration Study Area

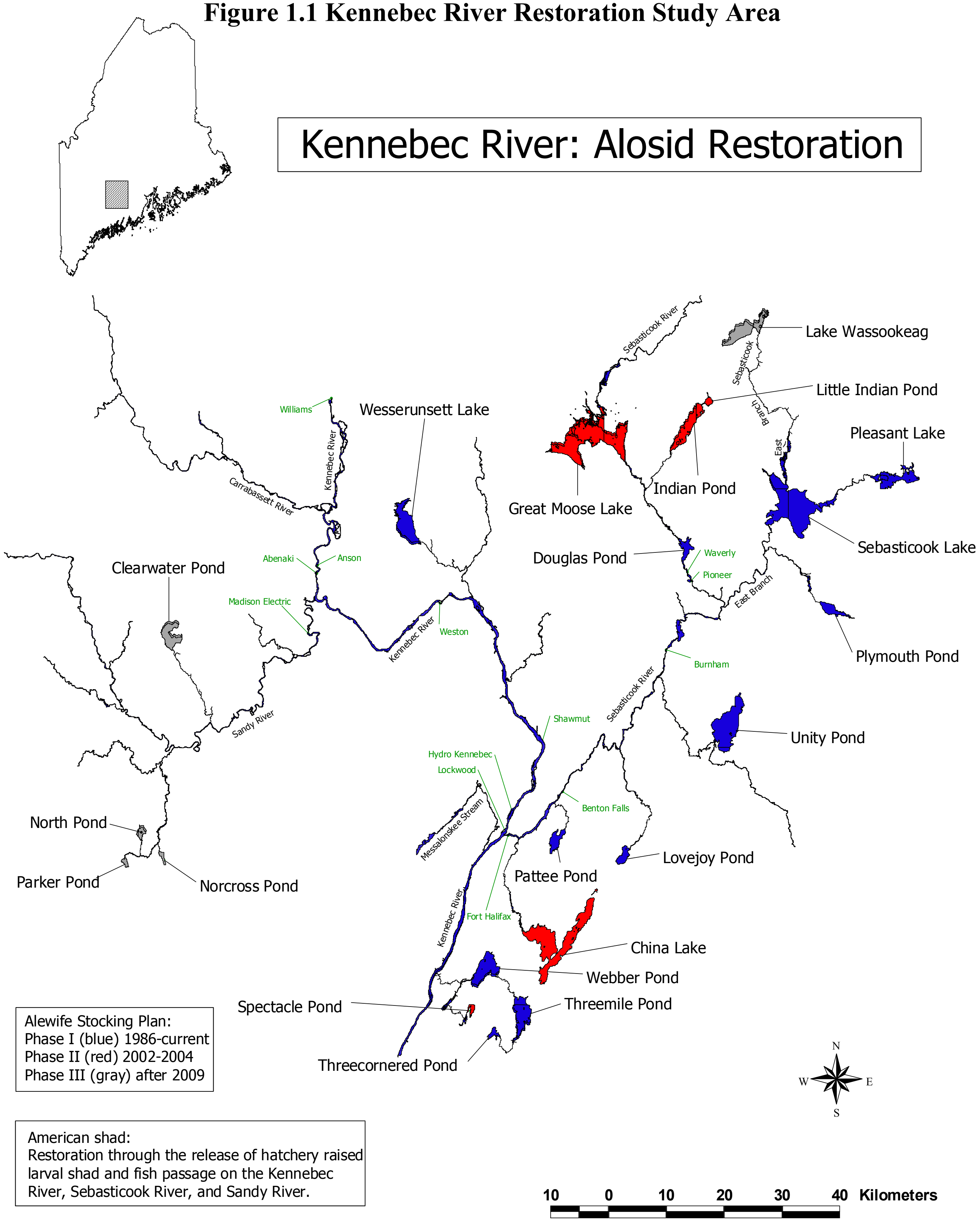

Figure 1.2 Numbers of fish stocked into Webber Pond in 2008

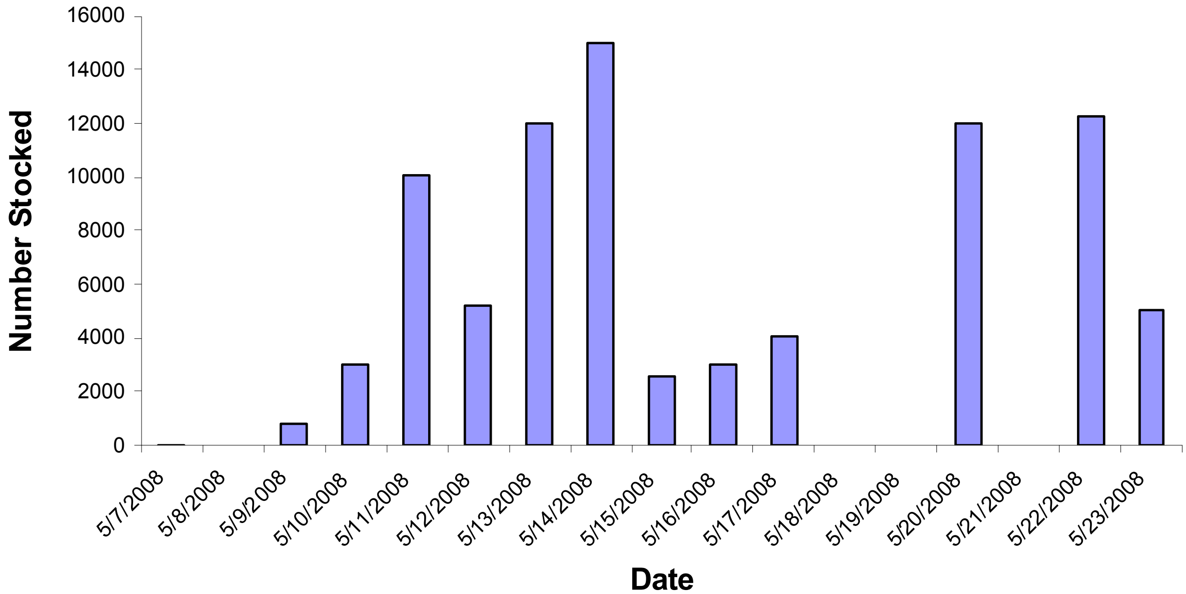

Figure 1.3 Male vs Female - Length & Weight Ft. Halifax

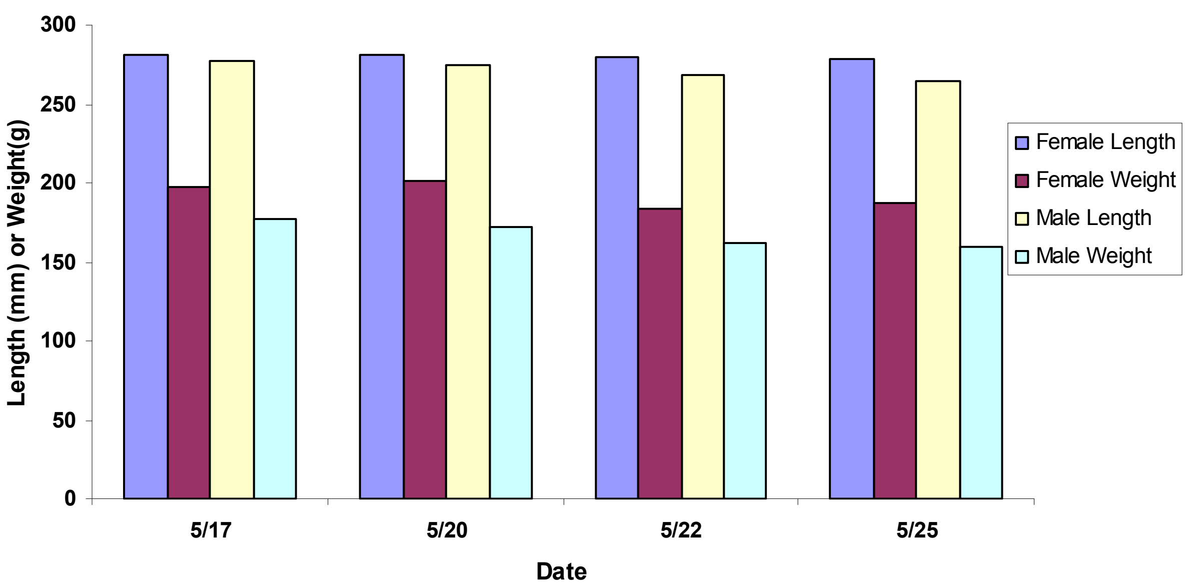

Figure 1.4 Male vs Female - Length & Weight Webber Pond

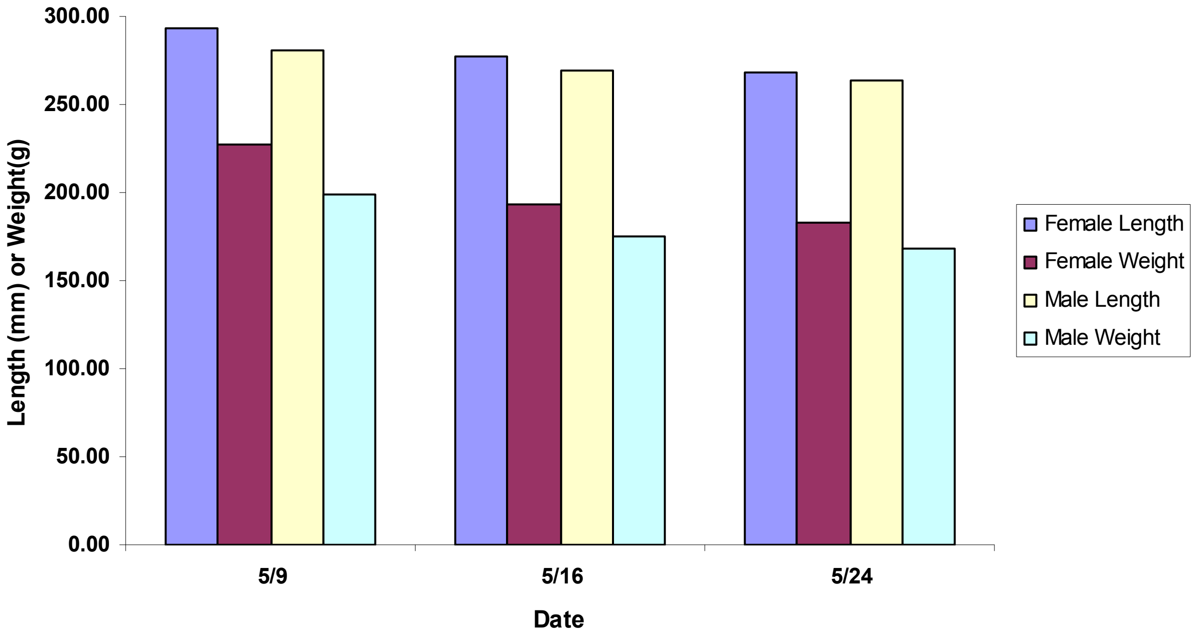

Table 1.1 Summary of Alewife Trapping by Quartile and Peak Alewife Trapping

Year	Capture site	25%	50%	75%	Peak date	Number Stocked (peak day)
2008	**Winslow**	**17-May**	**19-May**	**23-May**	**17-May**	**49,330**
2007	Winslow	23-May	26-May	28-May	27-May	88,950
2006	Winslow	9-May	9-May	28-May	9-May	12,358
2005	Winslow	18-May	21-May	3-Jun	18-May	15,272
2004	Winslow	13-May	18-May	24-May	13-May	16,752
2003	Winslow	21-May	27-May	30-May	21-May	15,467
2002	Winslow	11-May	20-May	23-May	20-May	15,867
2001	Winslow	12-May	14-May	16-May	14-May	18,896
2000	Winslow	9-May	15-May	19-May	7-May	13,578
	Average	**14-May**	**18-May**	**25-May**	**16-May**	

Table 1.2 Alewife Stocking & Distribution, Phase I and II Lakes, 2008

Ponded Area	Location	Surface Acres	River Section	Stocking Goal[1]	Actual Stocked 2008	Alewives per Acre
Corundel Lake	Corinna	225	Sebasticook, E. Branch	2,000	3500	15.6
Douglas Pond	Pittsfield	525	Sebasticook, W. Branch	18,375*	17699	33.7
Lovejoy Pond	Albion	324	Sebasticook, mainstem	1,944	0	0.0
Halifax Headpond	Winslow	---	Sebasticook, mainstem	---	401331	---
Pattee Pond	Winslow	712	Sebasticook, mainstem	---	***	---
Pleasant Pond	Stetson	768	Sebasticook, E. Branch	---	1117***	1.5
Plymouth Pond	Plymouth	480	Sebasticook, E. Branch	---	***	---
Burnham Headpond	Pittsfield	600	Sebasticook, E Branch	---	***	---
Sebasticook Lake	Newport	4,288	Sebasticook, E. Branch	---	84955***	19.8
Unity Pond	Unity	2,528	Sebasticook, mainstem	---	***	---
Big Indian Pond[2]	St. Albans	990	Sebasticook, W. Branch	5,940	0	---
Little Indian Pond[2]	St. Albans	145	Sebasticook, W. Branch	870	0	---
Great Moose Lake[2]	Hartland	3,584	Sebasticook, W. Branch	21,504	0	---
Webber Pond Drainage	Vassalboro/ Augusta/China	2,653	Kennebec River	92852*	85,022	32.0
Wesserunsett Lake	Madison	1,446	Kennebec River	8,676	9,855	6.8
Totals:		**18,944**			**513,907**	

[1] Six adult alewives per lake surface acre unless noted with an *

[2] Phase II lakes

*** Fish passage available from Fort Halifax Headpond

Table 1.3 Disposition of Kennebec River Alewives Distributed in Locations Other Than Phase I Lakes, 2008

Drainage	Location		Number Loaded	Number Mortalities	Number Released
Bagaduce	Pierce Pond				
		Total:	**0**	**0**	**0**
Kennebec	Pleasant Pond (Cobbossee Stream)		7000	0	7000
	Nehumkeag Pond		974	3	971
	Shawmut Headpond		37050	9	37041
		Total:	**45,024**	**12**	**45,012**
Pemaquid	Pemaquid Pond				
	Pemaquid River				
		Total:	**0**	**0**	**0**
Seal Cove	Seal Cove Pond-MDI		1,750	0	1750
		Total:	**1750**	**0**	**1750**
Union	Lower Patten Pond		3500	2	3498
		Total:	**3,500**	**2**	**3,498**
Webber Pond	Webber Pond – Bremen		1750	1	1749
		Total:	**1,750**	**1**	**1,749**
Great Pond	Franklin-Taunton Bay		1,300	0	1,300
Donnell Pond			2,310	1	2,309
		Total:	**3,610**	**1**	**3,609**
Somes	Somes Pond Somesville-MDI				
		Total:	**0**	**0**	**0**
Storer Pond	Medomak		1000	3	997
		Total:	**1,000**	**3**	**997**
Tilden Pond	Ducktrap		1200	4	1196
			1000	0	1000
		Total:	**2,200**	**4**	**2,196**
		Total Fish:	**58,834**	**23**	**58,811**

Table 1.4 Age Distribution of Adult Alewives Collected at Fort Halifax, 2008

Sample Date	Age III		Age IV		Age V		Age VI		Mean Age	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
17-May	0	0	6	3	5	5	0	0	4.5	4.6
20-May	0	0	5	2	6	2	0	1	4.5	4.8
22-May	0	0	5	5	2	3	0	1	4.3	4.6
25-May	4	0	5	5	2	0	0	0	3.8	4.0
∑=	**4**	**0**	**21**	**15**	**15**	**10**	**0**	**2**	4.3	4.5
% By Sex	**10.0**	**0.0**	**52.5**	**55.6**	**37.5**	**37.0**	**0.0**	**7.4**		
% of Total	**6.0**	**0.0**	**31.3**	**22.4**	**22.4**	**15.4**	**0.0**	**3.0**		

Table 1.5 Age Distribution of Adult Alewives Collected at Webber Pond, 2008

	Age 3	4	5	6	7	Total
Female #	1	6	10	1	1	19
Male #	1	10	17	1	0	29
Female %	2%	13%	21%	2%	2%	
Male %	2%	21%	35%	2%	0%	

Table 1.6 Age Distribution of River Herring Collected at Lockwood, 2008

	Age 3	4	5	Total
Female #	0	15	17	32
Male #	3	20	11	34
Female %	0%	23%	26%	
Male %	5%	30%	17%	

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Sebasticook River Fish Passage

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Executive Summary

MDMR continued to assess upstream fish passage efficiency at four restoration projects in the Sebasticook River, and obtain biological information necessary for managing restored populations. To date only alewife have been studied, because the fish pump at Fort Halifax does not capture and pass American shad and blueback herring. MDMR made visual counts at the Fort Halifax Dam and Sebasticook Lake fishway; hydropower owners utilized electronic fish counters at the Benton Falls and Burnham projects; and MDMR deployed PIT-tag detection antennas in the Benton Falls fishlift, Burnham fishlift, Sebasticook Lake fishway, and Plymouth Pond fishway. A total of 401,331 alewife were passed into Fort Halifax headpond from 5/14-5/27, and 84,595 adult alewives entered Sebasticook Lake from 5/18-6/5. Cumulative daily counts at Benton Falls exceeded those at Fort Halifax, but the apparent underlying problem should be eliminated in 2009. The number of alewife passed at Burnham (156,549) and Sebasticook Lake were 69% and 45%, respectively, of the number expected based on habitat. A total of 114 (22%) of the 510 PIT-tagged alewives were detected at upstream locations, but the number detected declined with tagging date. Approximately one-half of the PIT-tagged fish detected at Sebasticook Lake were not recorded at the downstream Burnham Project, and may have bypassed the antenna (and counter) by swimming through a hole in the guidance funnel. Twenty-seven (26%) of the fish detected at the Sebasticook fishway entrance were not detected at the exit, and nine were detected at the exit but not at the entrance. As in 2007, no tagged fish were detected at either the lower or upper fishways at Plymouth Pond, although MDMR biologists saw alewives entering the lake on several occasions. The average travel time from Fort Halifax to Burnham was 3.6 days and from Fort Halifax to the Sebasticook fishway entrance was 4.9 days, similar to travel times in 2007. The lower than expected number of alewife at upstream habitat and their poor passage into Sebasticook Lake may be the result of early high flows that delayed passage at Fort Halifax until 5/14.

Introduction

MDMR initiated this project to assess upstream fish passage efficiency at four CRP-funded restoration projects located in the Sebasticook River, Maine, and to obtain biological information necessary for the sustainable management of three anadromous species (alewife, American shad, blueback herring) being restored to the drainage. Specific project objectives were to determine:

- the efficiency with which anadromous species pass the CRP-funded projects;
- the progress of fish restoration and the accuracy of MDMR's fish production estimates;
- the time required for upstream migration of each species;
- the length of time that adults of each species remain in spawning habitat;
- the proportion of adults of each species that survive spawning; and
- the timing of closed periods that will best ensure a sustainable commercial alewife harvest.

Methodology

The study was conducted in the Sebasticook River (Fig. 2.1), the largest tributary of the Kennebec River, and encompassed three hydropower projects (Fort Halifax, Benton Falls, and Burnham) and four CRP-funded restoration projects at nonhydropower dams (fishway at Sebasticook Lake Dam, two fishways at Plymouth Pond Dam, breach of Guilford Dam, and channel restoration upstream of breached dam). Fish counts were used to document large scale population movements in the river, and PIT-tagging was used to monitor the movements of individual fish.

Fish counts

MDMR biologists made visual fish counts at the Fort Halifax Project and the Sebasticook Lake fishway, while hydropower Licensees counted fish at the Benton Falls Project and the Burnham Project with an electronic fish counter (Smith-Root model SR-1601). MDMR initially installed the same model electronic fish counter and a trap at the outlet of Sebasticook Lake, but removed the counter when alewives would not pass through it. Apparently flow attracted fish to the side of the trap rather than to the end with the counting tubes.

All electronic fish counter installations were similar, and consisted of an array of 16 counting tubes that was connected to the electronic counter. Each counting tube was made of a 20-inch long section of ¼-inch thick, 4-inch diameter, Schedule 40 PVC pipe. The inner wall of the pipe was fitted with three four-inch, stainless steel hose clamps set five inches apart; three slots were cut in each pipe to expose the bolt of the hose clamp. The 16 counting tubes were arranged in a 2x8 configuration in a wooden frame, and spaces between the counting tubes were filled with smaller diameter PVC pipe to exclude fish. Each of the three hose clamps in each of the 16 counting tubes was connected to the electronic fish counter via a Smith-Root tunnel junction box. At each of the two hydropower projects the fish counter was installed in the exit flume of the fishlift, and a large funnel made of wood and wire mesh was installed to guide fish towards the counting tubes. In addition, at Benton Falls an excluder made of aluminum pipes spaced 1-inch apart (i.e. 1-inch clear space) in a wooden frame was placed in front of the counting tubes to prevent fish larger than an alewife from entering them and creating spurious counts.

Passive Integrated Transponder (PIT)-Tagging

PIT tag readers/dataloggers and antennas were installed and tested in the Benton Falls fishlift, the Burnham fishlift, the entrance and exit of the Sebasticook Lake fishway, the entrance of the lower Plymouth Pond fishway, and the exit of the upper Plymouth Pond fishway (Fig. 2.1) from 5/14-5/19. Each antenna consisted of three windings of THHN 12-gauge cable inside a 2-ft x 3.5-ft rectangle constructed of 1-in diameter PVC electrical conduit, which was clamped to a wooded frame. At each hydropower site the antenna was placed about 18 inches upstream of the electronic fish counter tubes. At the other sites, the frame was bolted to the downstream face of the upper or lower chute of the fishway. After an antenna was connected to a datalogger-tuner unit (Oregon RFID half-duplex single reader) and a 12-V battery, the antenna was tuned.

On four dates (Table 2.1), fish to be tagged were pumped from the Fort Halifax Project tailrace into a flume, netted, and measured. A small incision (1/2 inch) was made on the right side of the fish with a scalpel, and a PIT tag (23 mm HDX glass encapsulated) inserted in the body cavity. All fish were immediately released into the headpond via the flume, because no mortality occurred in fish held up to 72 hours in 2007.

RESULTS

Fish counts

In 2008, MDMR biologists passed 401,331 adult alewives into the Fort Halifax headpond between 5/14 and 5/27 and 84,595 adult alewives into Sebasticook Lake between 5/18 and 6/5 (Fig. 2.2). Cumulative daily counts at Benton Falls Project[2] exceeded those at the Fort Halifax Project, which may have resulted when some fish exiting the Benton Falls flume were entrained into the attraction water pipe, released into the fishlift hopper, relifted to the exit flume, and recounted. This problem will be corrected prior to the 2009 migration season, but the magnitude of error in fish counts caused by "recycling" alewives at Benton Falls is unknown. A total of 156, 549 fish were reported to have passed at the Burnham Project[1], which represents 69% of the alewives expected to pass on the basis of upstream habitat area. The number of alewives that entered Sebasticook Lake also was lower than expected. Approximately 45% of the 188,651 alewives expected on the basis of habitat area in Sebasticook Lake and Pleasant Pond actually passed at the Sebasticook Lake fishway.

PIT tagging

The PIT-tag reader at Benton Falls inexplicably lost power four days after it was installed, and automatically shut down on 5/18. As a result no detections were recorded at this location, and the number of tagged individuals that passed is unknown.

A total of 114 (22%) of the 510 PIT-tagged alewives were detected at upstream locations. The number detected upstream declined with tagging date from 45% for fish tagged on 5/19 to 17% for fish tagged on 5/23 (Table 2.1). Approximately one-half of the fish detected at Sebasticook Lake were not recorded at the Burnham Project (Table 2.1), which is located downstream. We believe fish were able to pass through a large hole in the guidance funnel at Burnham, which was not visible until the fishlift was dewatered in late summer. Twenty-seven (26%) of the fish detected at the Sebasticook fishway entrance were not detected at the exit, and nine were detected at the exit but not at the entrance. As in 2007, no tagged fish were detected at either the lower or upper fishways at Plymouth Pond, although MDMR biologists saw alewives entering the lake on several occasions.

The average travel time from Fort Halifax to Burnham was 3.6 days (s.d. 1.7, range 1.8-9.9 days) and from Fort Halifax to the Sebasticook fishway entrance was 4.9 days (s.d. 2.0, range 2.7-14.2 days). These times are similar to 2007 when three fish were recorded at Burnham 2-5 days after being tagged and released at Fort Halifax.

DISCUSSION

Although over 400,000 alewife were passed at Fort Halifax in 2008, the number that arrived at upstream habitat was substantially less than expected based on amount of spawning habitat.

[2] Fish counts at the Benton Falls Project and Burnham Project are provisional data subject to revision.

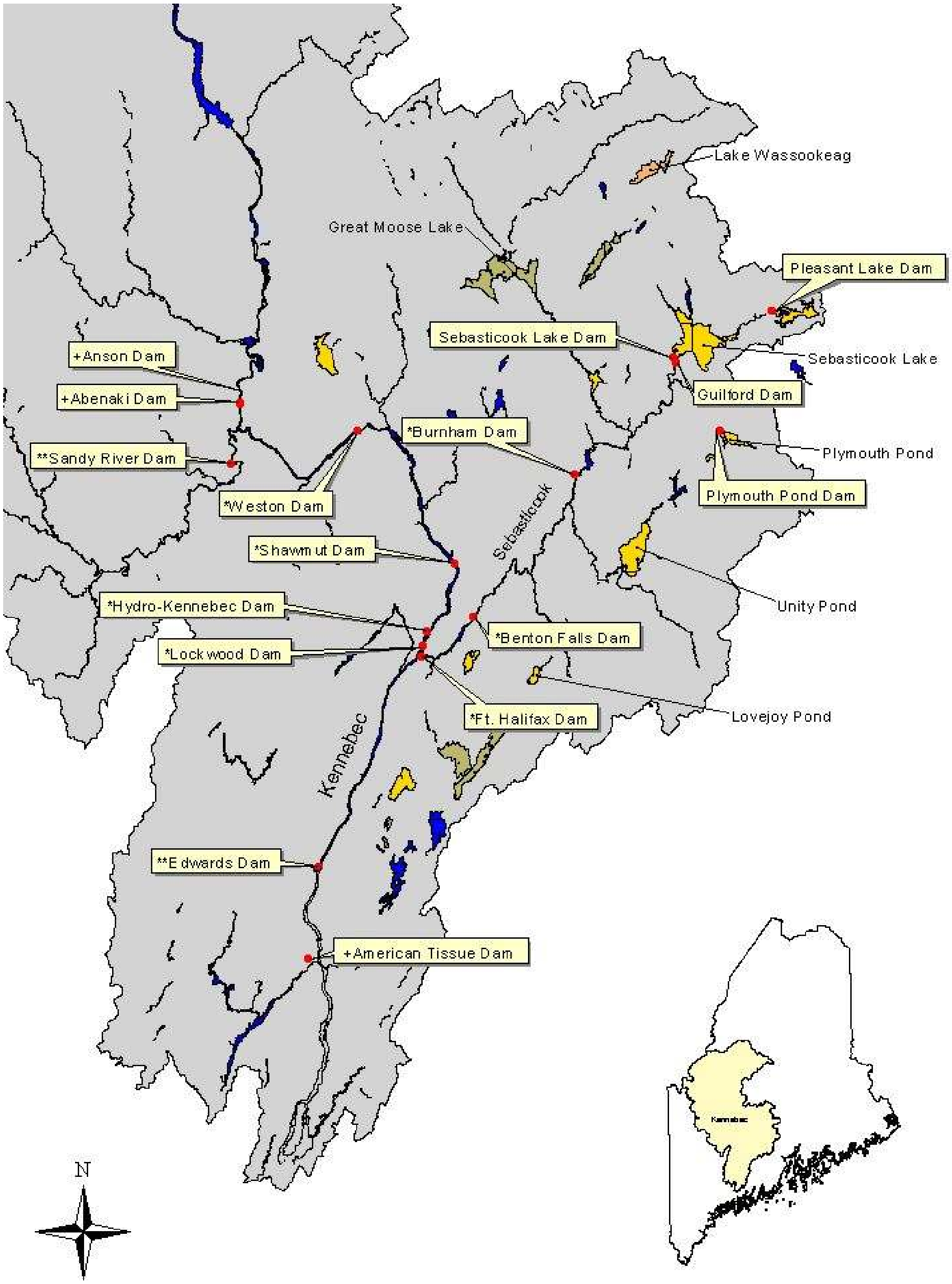
Alewife also appeared to have difficulty passing into Sebasticook Lake via the fishway, although river discharge had decreased when these fish were migrating upstream (Fig. 2.2; Fig. 2.3). Because of high flows, the Fort Halifax pump did not become operational until 5/14. It is possible that alewife became exhausted while waiting below Fort Halifax, and spawned in the first available habitat (e.g. Fort Halifax headpond, Benton Falls headpond, Pattee Pond, Unity Pond). Fort Halifax Dam was removed in 2008, and DMR expects to see significant changes in run timing and the composition of upstream migrants in 2009.

TABLE 2.1. SUMMARY OF TAGGING AND DETECTIONS OF TAGGED FISH IN THE SEBASTICOOK RIVER 2008, AT THE BURNHAM PROJECT AND THE ENTRANCE AND EXIT OF THE SEBASTICOOK LAKE FISHWAY.

Date tagged	Number tagged	Tags detected 2008	%	Tags at BU 2008	Tags at SLB 2008	Tags at SLT 2008	Tags at PP 2008
5/19/2008	112	51	45.5	19	46	43	0
5/20/2008	97	37	38.1	14	34	24	0
5/23/2008	151	26	17.2	15	24	19	0
5/27/2008	150	0	0.0	0	0	0	0

Figure 2.1. Location of hydropower projects and fishways within the Kennebec River watershed.

KHDG



hydropower projects indicated by star (*), hydropower projects that have been removed by two stars (**), other hydropower projects by plus (+), and nonhydropower dams have no symbol. Figure has not been updated to reflect removal of Fort Halifax Dam in late 2008.

Figure 2.2. Fish counts at four Sebasticook River sites in 2008.

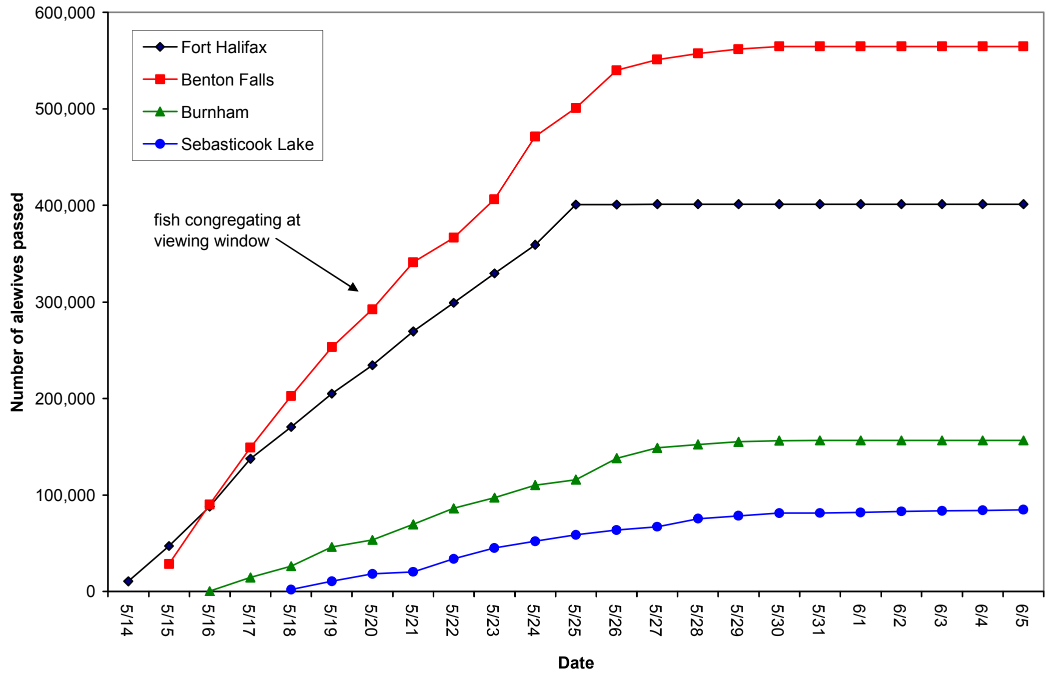
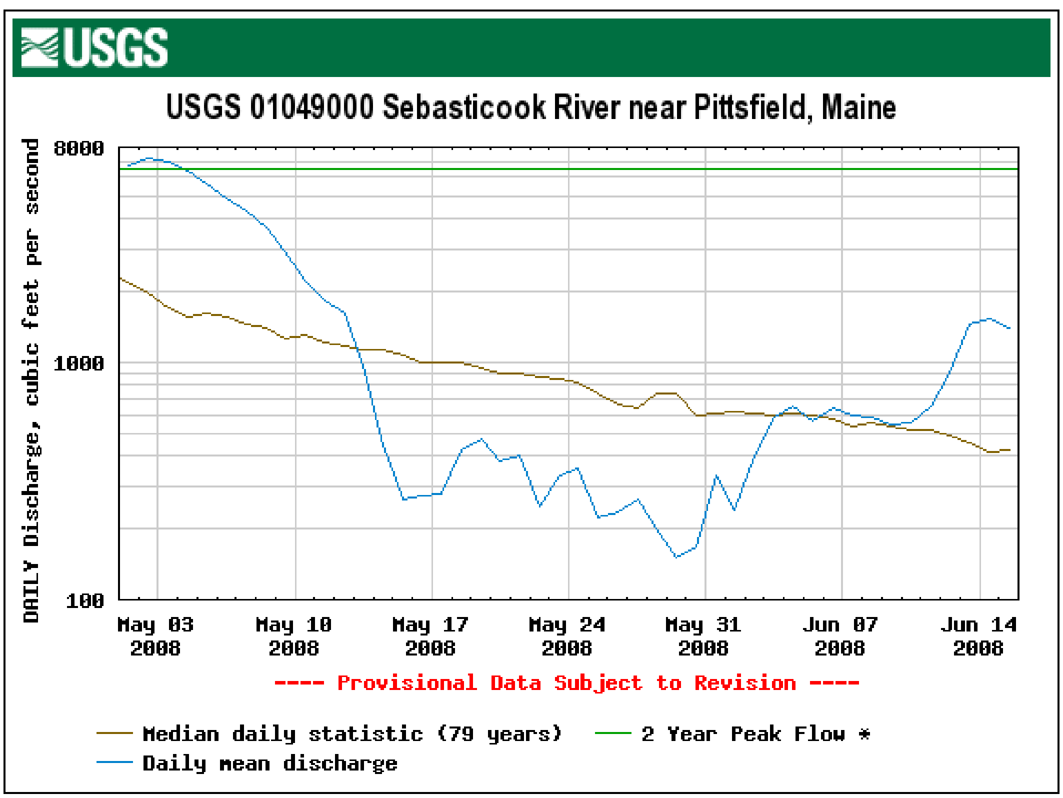


Figure 2.3. Mean daily freshwater discharge (blue line) in the Sebasticook River in 2008.



KHDG

American Shad Restoration

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3.0 Executive Summary

In 2008, Six-hundred-and-fourteen fish were transported to the Waldoboro Shad Hatchery Waldoboro Shad Hatchery produced 4,283,929 American shad fry. Between June 23 and July 9, an estimated 3,283,136 shad larvae were released just below the Shawmut Project on the Kennebec River. Between July 18 and July 22, an estimated 288,507 shad larvae were released just below the Lockwood Project on the Kennebec River. 712,286 shad fry were released into the Androscoggin River.

3.1 Adult Capture and Transport

The shad culture program initiated in 1991 was continued in 2008. The Kennebec River Shad Restoration Program began as a cooperative effort between MDMR, the KHDG, the Town of Waldoboro, and the Time & Tide Mid-Coast Fisheries Development Project, the latter of which was created and administered by the local Time & Tide Resource Conservation and Development Organization. The hatchery is now privately owned and operated by Sam Chapman. It is located in the Town of Waldoboro and consists mainly of two 15-foot diameter adult spawning tanks, one 12-foot diameter adult spawning tank, and seven six-foot diameter larval rearing tanks. There are also three outdoor settling ponds formerly used for the production of shad fingerlings.

The Merrimack River Technical Committee allotted Maine 400 shad until 15,000 fish passed Lawrence fishway, then the remaining 1200 fish of the requested 1600 fish could be hauled. The USFWS suppied MDMR with the results of their fish health work negating our need to sacrifice 60 fish for our own pathology. Transfer of adult shad broodstock from the Lawrence fish lift to the Waldoboro Shad Hatchery began on May 30. This year MDMR visited the Lawrence site 6 times, 5 trips were made to the Waldoboro Shad hatchery, 1 trip was made to the Androscoggin River. A total of 638 fish were collected from the Lawrence fishlift.

Six-hundred-and-twenty fish were transported to the Waldoboro Shad Hatchery, of which 614 survived the trip (Table 3.1). Eighteen fish were transported and released into the Androscoggin River with all 18 surviving the trip. The average over all hauling mortality was >1%. A total of 614 fish from Lawrence went into the hatchery and produced 4,283,929 fry. Of the 638 fish 299 adult shad survived the hatchery process. Two-hundred-thirty-nine were loaded into a stocking truck and transported back to the ocean. Two-hundred-thirty-six survived the trip and were released at the boat launch in the mouth of the Medomak River in Waldoboro, ME. An additional 60 fish were sacrificed to assess spawning condition. Additionally hearts were collected from these 60 individuals and sent to Jacob L. Gregg of Marrowstone Marine Field Station U.S. Geological Survey - Biological Resource Discipline for a Ichthyophonus workup.

In order to improve egg production at the hatchery, Andrew Chapman accompanied MDMR staff and hand-selected large healthy females as broodstock, as well as healthy males. All shad were placed in a spawning tank and allowed to spawn over the next several weeks. The fertilized eggs were collected, disinfected, and placed in upwelling incubators. After hatching, the larvae were raised in 575-gallon circular fiberglass tanks and fed brine shrimp.

No American shad were captured with the Fort Halifax fish pump in 2008. No adult shad were captured in the Lockwood fish lift on the Main-stem Kennebec in Waterville in 2008. This was the lift's third year in operation. DMR will continue to work with FPL in attempt to determine why shad are not successfully utilizing the fishway.

3.2 Larval Culture and Transport

All adult shad transported to the hatchery were placed immediately into either one of the two 15-foot diameter spawning tanks. Shad were allowed to spawn "naturally," the eggs collected daily and placed into upwelling incubator jars. The resultant larva were reared to approximately 6-13 days old before being released. While in the hatchery, all larvae are marked with oxytetracycline

("OTC"), an antibiotic that leaves a mark on the otolith, or inner ear bone. When viewed under a microscope equipped with fluorescent light MDMR can distinguish adult returns as either hatchery or wild in origin based on the presence of an "OTC" mark. Otoliths from a 20-fish sample from each batch of fish were examined for OTC mark retention. 2008 marked the second year in which the hatchery double marked the otoliths producing a double ring, a more distinctive mark, reducing the probability of a false positive. Additionally in 2008 two releases were triple marked.

Larval shad are loaded into a stocking tank and released directly into the target river. At the hatchery, they are drained from their rearing tank directly into a four-foot diameter hauling tank that is affixed to the bed of a ¾-ton pickup truck. Upon arrival at the stocking site, temperatures of the hauling water and river are assessed. If needed, river water is bucketed into the hauling water to gradually temper hauling water. Larval shad are then released into the river by draining the hauling tank through a hose attached to the bottom drain of the tank. Several five-gallon buckets of river water are poured through the tank to rinse any remaining larvae into the river. In 2008, no larval shad were intentionally released into the outdoor hatchery ponds for the production of fingerlings.

In 2008 the Waldoboro Shad Hatchery produced 4,283,929 American shad fry. Between June 23 and July 9, an estimated 3,283,136 shad larvae were released just below the Shawmut Project on the Kennebec River. Between July 18 and July 22, an estimated 288,507 shad larvae were released just below the Lockwood Project on the Kennebec River (Table 3.2). 712,286 shad fry were released into the Androscoggin River. The 2008 total of 3,571,643 larvae released into the Kennebec drainage is less than 2007 number of 8,360,359 and is higher than average (Figure 3.1).

Based on the results of over a decade of research in the successful American shad restoration of the Connecticut River, MDMR biologists have estimated the production potential of shad in the Kennebec watershed. Table 3.3 shows the yearly natural production potential by river segment, adjusted for 10% mortality resulting from passage through each hydroelectric facility in the river reach, within the historical range of American shad.

In 2008, MDMR personnel made few observations at the Fort Halifax tailrace for the presence of shad. No shad were observed in the Fort Halifax tailrace. Observations varied in duration as time allowed. Generally shad are observed nearing the end of the alewife run at Fort Halifax. In 2008 MDMR's efforts to move river herring at Fort Halifax ended much earlier than in previous years due to meeting our escapement quota. Shad may not have been observed in 2008 due to our not being present during the time they are generally observed. MDMR did e-fish and capture shad in the Fort Halifax tailrace 7/1-7/3.

3.3 Juvenile Assessment

Since all young-of-year shad released from the hatchery are marked with OTC (marks confirmed by MDMR at time of stocking) , MDMR is able to assess the relative contribution of hatchery-reared shad to the Kennebec River shad population. Starting in 2000, adult and young-of-year shad collected in the Kennebec were kept for OTC mark analysis. 25 adult shad were intentionally killed for this study. None of the adults collected had visible OTC marks. Young-of-year shad were collected during biweekly beach seine surveys (see FISH COMMUNITY ASSESSMENT in this report for complete details on capture sites and techniques). Otoliths were removed, cleaned in distilled water, and mounted in a thermoplastic resin. Lapping film (9, 3, and 1 micron grit) was used to grind each otolith to mid-saggital plane on one side; otoliths were then flipped over and ground to mid-saggital plane on the opposite side. A drop of Type FF, low fluorescing, immersion oil was placed on each ground otolith and then covered with a glass cover slip. Otoliths were then viewed under a compound microscope equipped with fluorescent light and a FITC filter set. With this microscope configuration, any fish marked with OTC would exhibit a glowing ring for the day that fish was marked (2 rings in 2007 and 2008). As of 1/13/2009 otoliths were successfully processed for 540 juvenile shad collected in 2008. Of the 540 shad only 12 individuals contained an OTC mark demonstrating hatchery origin contribution of 2.2% of our samples, however it should be noted that 154 of those sampled were collected at the end of September and were of a size (<30mm) making it very improbable that these could be hatchery origin fish. None displayed a hatchery mark. All of the 12 marked shad were in the group of 386 sampled earlier in the year. Just looking at these individuals hatchery contribution would be 3.1%.

During the 2008 beach seine effort, 669 juvenile shad were captured at 4 different sites, with the highest number captured at Site 8C (392). A Juvenile Abundance Index "JAI" was calculated for juvenile shad captured in 2008 (Table 3.4). The index for all sites was 63.55 shad/seine haul. Of all the sites sampled in 2008, site 8C had the highest comparative JAI of 196 shad/seine haul, followed closely by site 8B with 133 shad/seine haul. A geometric mean was calculated for juvenile shad captured in 2008 (Table 3.4). The geometric mean for all sites was 6.46. Depending on river flows, there is slack water or an eddy at Site 8C. Habitat suitability models indicate that larval shad prefer large eddies[3], which may explain why younger shad are found there. Seining effort was greatly reduced in 2008 due to high river flows causing unsafe conditions (>6000 CFS) (Figure 3.2).

[3] Ross, R. M., T. W. H. Backman, and R. M. Bennett. 1993. Evaluation of habitat suitability index models for riverine life stages of American shad, with proposed models for premigratory juveniles. U.S Fish and Wildlife Service Biological Report 14. 26pp.

Figure 3.1 American Shad Larvae Released in the Kennebec Drainage, 1993-2008

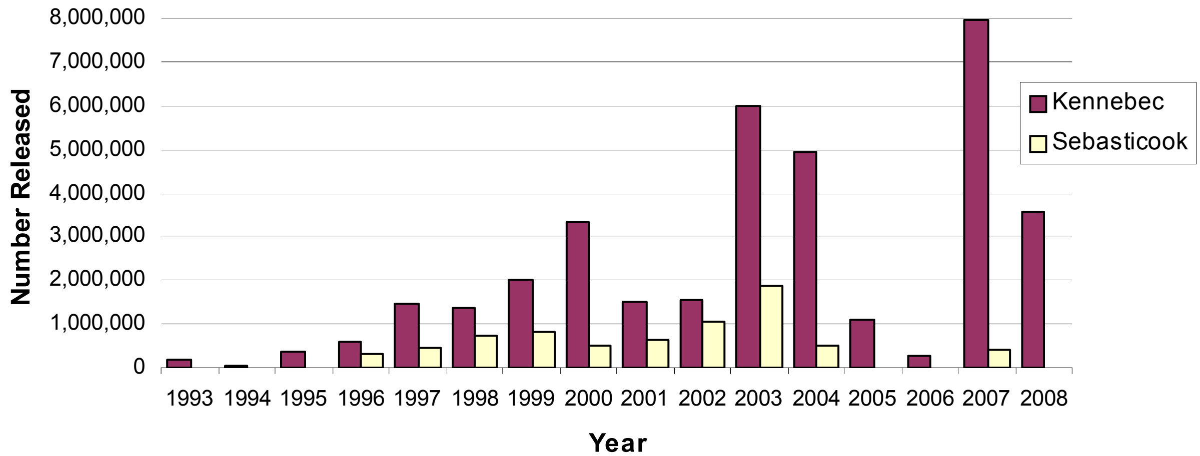

Figure 3.2 USGS Daily Discharge for Kennebec River at North Sidney demonstrating MEDMR seining safety cutoff

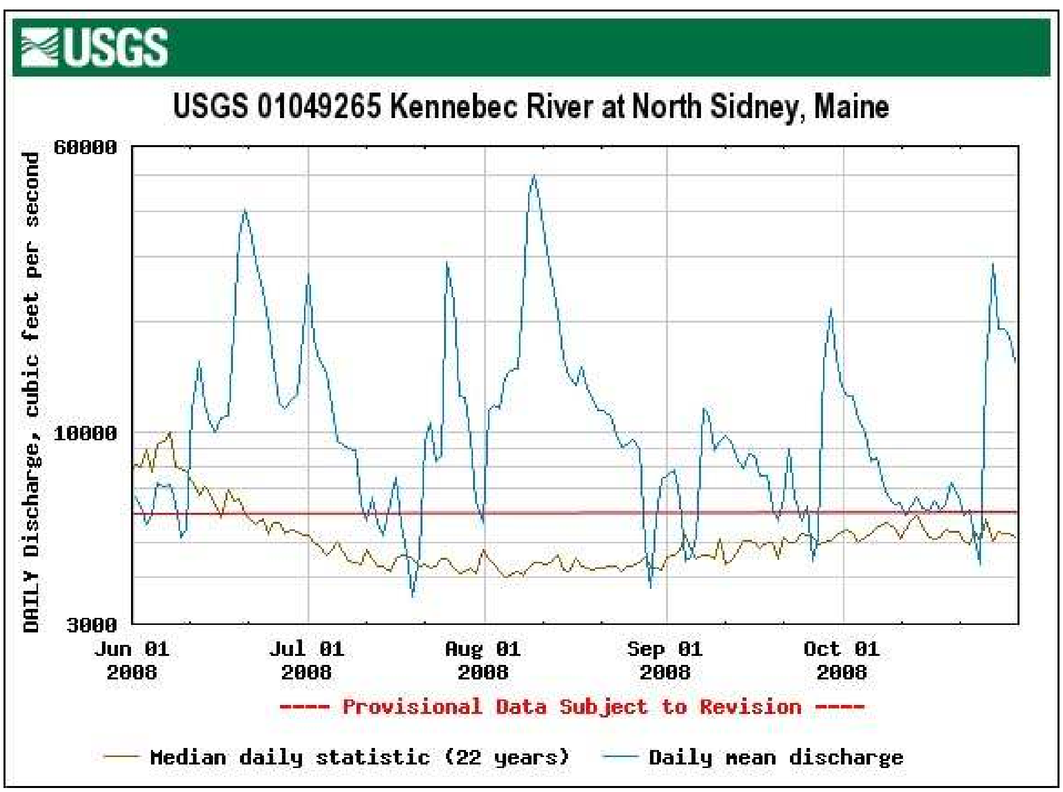

Table 3.1 Transfers of American Shad Broodstock to Waldoboro Hatchery, 2008

Source	Trapping Site	Date	Number Loaded	Number Mortalities	Number In Hatchery
Merrimack River	Essex Lift	5/30/2008	150	2	148
		6/4/2008	150	2	148
		6/5/2008	50	0	50
		6/10/2008	180	2	178
		6/16/2008	90	0	90
	Total		**620**	**6**	**614**

1% trucking mortality

Table 3.2 Larval American Shad Releases, 2008

Receiving Location	Date Stocked	No. Stocked
KENNEBEC-BELOW SHAWMUT	6/23/2008	347536
KENNEBEC-BELOW SHAWMUT	6/25/2008	845704
KENNEBEC-BELOW SHAWMUT	7/1/2008	745002
KENNEBEC-BELOW SHAWMUT	7/7/2008	693207
KENNEBEC-BELOW SHAWMUT	7/9/2008	651687
KENNEBEC-BELOW LOCKWOOD	7/18/2008	203374
KENNEBEC-BELOW LOCKWOOD	7/22/2008	85133
	Total	**3571643**

Table 3.3 Annual Production Numbers for American Shad for the Kennebec River Watershed above Augusta.

River Segment	Habitat Units (100 sq. yd.)	Potential Shad Production[2]	Potential Shad Production With 10% Downstream Mortality[3, 4]
Sandy River above Madison Electric Dam, Madison	36,370	83,650	44,455 (5)
Kennebec River above Weston Dam, Skowhegan	55,869	128,498	75,877 (4)
Kennebec River from Shawmut Dam, Fairfield to Weston Dam	61,252	140,879	92,431 (3)
Kennebec River from Hydro Kennebec Dam, Waterville to Shawmut Dam	25,314	58,221	42,443 (2)
Kennebec River from Augusta to Lockwood Dam, Waterville	63,066	145,053	130,547 (1)
Sebasticook River above Burnham	22,986	52,867	34,686 (3)
Sebasticook River from Benton Falls to Burnham Dam, Burnham	20,847	47,948	34,954 (2)
Sebasticook River from Fort Halifax Dam, Winslow to Benton Falls, Benton	14,199	32,658	26,453 (1)
Total Kennebec	**205,501**	**472,651**	**341,298**
Total Sebasticook	**58,032**	**133,473**	**96,093**
Total, Kennebec watershed above Augusta	**263,533**	**689,774**	**481,846**

[1] Based on 10% downstream mortality at each hydroelectric dam

[2] Based on estimates derived from Connecticut shad restoration efforts of 2.3 adult shad per Habitat Unit

[3] 10% mortality estimates based on a theoretical efficiency goal

[4] Number in parentheses represents the total dams from that area downstream

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Status of Fish Passage

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4.0 Executive Summary

MDMR personnel checked pond outlet dams from July through November. Down stream passage varied site to site. Most locations had adequate passage during peak fall emigration. Bypass facilities were operating at all projects during all visits.

4.1 Upstream Passage

The Kennebec River Restoration Program was initiated following the development of a Strategic Plan in 1985, an Operational Plan in 1986, and the signing of an Agreement in 1986 between the Department of Marine Resources (MDMR) and the Kennebec Hydro Developers Group (KHDG). This Agreement provided a delay in fish passage requirements at seven hydropower facilities above Augusta in exchange for funds to initiate the restoration by means of trap-and-truck of alewife and American shad to selected upriver spawning and nursery habitat. In 1998, a new Agreement between state and federal fisheries agencies and the members of the KHDG was signed. The new Agreement provided for the removal of Edwards dam, included new timetables or triggers for fish passage at the seven hydropower facilities above Augusta, and provided additional funds to continue the restoration by trap-and-truck. A more detailed history of the restoration program, including management goals and objectives, is included in Appendix A.

In 2006, the Kennebec River Restoration Program entered a new phase when upstream anadromous fish passage became operational at the Benton Falls, Burnham, and Lockwood hydropower projects (Figure 4.1). The new fish lifts at Benton Falls and Burnham have made accessible nearly 100% of the riverine habitat and 43% of lacustrine habitat that was historically available to anadromous fishes in the Sebasticook River drainage, thereby allowing the Department of Marine Resources (MDMR) to reduce stocking operations in the drainage. Fish returning to the Sebasticook River in 2008 were collected at the first dam (Fort Halifax) with the Transvac pump and sluiced into the headpond; in previous years these fish had to be trucked upstream to spawning habitat. The fish lift at Lockwood allowed MDMR to capture fish imprinted specifically on the Kennebec drainage and move them upriver

SEBASTICOOK RIVER – FORT HALIFAX

Per the KHDG Agreement and the Project License, Florida Power Light Energy (FPLE) was required to install a permanent upstream fish lift at Fort Halifax by May 1, 2003, or breach the dam in 2003. In 2002, FPLE proposed to decommission and partially breach the dam in order to provide upstream passage. FERC approved FPLE's Application to Surrender its license and partially breach the dam on January 23, 2004. A Request for rehearing was filed by the Town of Winslow on February 19, 2004 and by Save our Sebasticook (SOS) on February 20, 2004. The Requests were denied by FERC on May 6, 2004. SOS subsequently filed a Petition for Review of Final Agency Action with the US Court of Appeals for the District of Columbia Circuit. The Petition for Review was dismissed in part and denied in part by the US Court of Appeals for the District of Columbia Circuit on December 9, 2005. SOS and other plaintiffs filed a Complaint for Declaratory and Other Relief with Maine Superior Court on August 16, 2004, seeking to invalidate the Lower Kennebec River Comprehensive Hydropower Settlement Accord. The Superior Court determined that the SOS action was untimely and dismissed the complaint. SOS appealed this decision to the Maine Supreme Court. The Maine Supreme Court issued a Memorandum of Decision on October 12, 2005 affirming the judgment of the Superior Court. The Law Court found "the Superior Court's well reasoned opinion correctly determined that the SOS action was untimely."
The Maine Department of Environmental Protection issued an Order approving the breaching of the Fort Halifax Dam on May 27, 2004. On August 16, 2004, SOS filed an appeal of DEP's action. The appeal was denied by the Board of Environmental Protection on February 22, 2005. S.O.S appealed the Board's decision to the Kennebec County Superior Court. The appeal filed by S.O.S. on

the Board’s decision approving the removal of Ft. Halifax Dam was dismissed in the Kennebec County Superior Court in August 2006. S.O.S subsequently appealed this decision to the Maine Supreme Court. On August 7, 2007, the Maine Supreme Judicial Court affirmed the judgment of the Maine Superior Court upholding a decision by the Maine Board of Environmental Protection to issue a permit to allow FPL Energy to partially breach the Fort Halifax Dam to provide for fish passage as agreed to in the 1998 Kennebec Hydro Developers Group (KHDG) Settlement Accord.

FPL Energy applied for Town permits to complete the permit process. The Town raised concerns regarding partial removal of the spillway, to address these concerns FPL applied to FERC to modify its order; seeking a full removal of the spillway. FERC issued a new order on July 1, 2008 approving full removal. The dam removal and site restoration activities were completed on October 31, 2008.

SEBASTICOOK RIVER –BENTON

Upstream passage at the Benton Falls was required to be operational one year following the installation of permanent or temporary upstream fish passage at Fort Halifax and following installation of permanent upstream fish passage at four upriver non-hydro dams. These projects included the implementation of interim upstream passage measures at Fort Halifax dam and the construction of fishways at the Pleasant Pond dam in Stetson, the Plymouth Pond dam in Plymouth, the Sebasticook Lake outlet dam in Newport and the removal of the Guilford dam in Newport. These projects were completed on June 13, 2003, triggering a June 14, 2004 date for fish passage to be operational.

Benton Falls submitted functional design drawings to FERC for a fish lift at the facility on January 3, 2005 and was subsequently approved by FERC on January 24, 2005. Fishway construction commenced mid summer 2005. Despite numerous flood events, unusually high water and setbacks construction was completed in time for the 2006 river herring run. MDMR, IF&W, USFWS, and the

Licensee have developed an agreement to incorporate a trapping and sorting facility in the Benton Falls fish passage facility. Functional design drawings were approved on May 7, 2006.

Narrative: On May 17 MDMR personnel received call from Benton Falls operator that the diffusion chamber excluder screens were plugged with alewives causing significant head differential between diffusion chamber and entrance flume. A subsequent site visit with the operator revealed many dead alewives upstream of the diffusion chambers excluder screens. The lift was shut down including attraction flows to prevent de-watering of the up-stream exit flume. The operator and DMR personnel removed the excluder screens and cleaned off the excluder panels. The panels were fitted with 1” plastic bar mesh to prevent alewives from entering the diffusion chamber.

On May 18 the diffusion chambers excluder panels were again plugged with dead alewives causing the head differential to rise. Not only does the head differential cause unwanted disturbance in the trap area but raises force applied to the excluder panels, a force they were not designed to resist. Again the fishway was shut down and the excluder panels removed and cleaned. Observations of the diffusion chamber were made to see if any alewives were present in the diffusion chamber prior to re-start of fishway operations. An underwater video camera was deployed into the diffusion chamber after the excluder panels had been re-installed. Some fish were visible in the diffusion chamber area but not a great number. New 1” bar plastic mesh was installed on both the excluder panels and the gap between the fish-lift superstructure, catwalk and diffusion chamber. This new plastic mesh was installed upon review of fishlift recordings showing some alewives leaping out of the fishlift hopper on its rise to the exit flume and into the diffusion chamber. Upon re-start, the attraction water having been used to flush the dead alewives form the entrance flume to prevent build up on the crowder gates had attracted a great number of alewives into the entrance flume. The first cycle of the fishlift saw the lift hopper choked with more fish than water and most of the alewives were seriously stressed when released into the exit flume. Several minutes were required for the fish to recover sufficiently to move up through the exit flume. With the excluder screens armored with 1” bar plastic net and the gap in the super structure closed the diffusion chamber head differential problem seemed solved.

On May 19th the operator called saying the excluder screens had plugged again to such a degree that they had failed. The subsequent failure and the head differential was enough to blow the crowder gate apparatus off its rails necessitating the shut down of the fishway. Not only had all the netting failed to exclude alewives but seemed to have exacerbated the condition. MDMR personnel and the Benton Falls operator spent considerable time and effort to relieve the diffusion chamber condition leading to multiple fishway shutdowns.

Some additional observations at Benton Falls included the excluder panels being a source of unacceptable mortality caused by the grating action on fish when the bucket rises out of the fishing position and transitions into the lift phase. Any alewives or other species on the “upstream” side of the lift bucket that were not in the bucket when it cleared the water would be ground to pieces between the bucket and the excluder panels. As the bucket ascended the excluder screens remained stationary in effect becoming a very large grating machine. The final interim solution at Benton falls consisted of the complete removal of the excluder screens to the diffusion chamber. This decision was arrived at mutually between MDMR and the Benton Falls operator. The removal of the excluder panels prevented alewives form being impinged on the upstream side causing a rise in head differential. The panels removal also prevented further structural failures in the entrance flume as witnessed by the crowder derailment that occurred on the 19th of May. Also, once removed, the excluder panels were no longer a mortality hazard to up-stream migrants should they be upstream of the hopper when it lifted.

A similar condition at Benton Falls existed in the operation of the separator screen. The separator screen is activated at the completion of the crowder cycle. When the crowder is in its full forward position the separator screen lowers and prevents fish from leaving the hopper area. Some mortality was noted on the separator screen side of the hopper when the lift occurred. Fish not in the hopper were subjected to grating the length of the separator screen much like the excluder panels. The interim solution to the separator screen condition was to lock out the separator screen in the "up" position. The crowder on its forward travel was close enough to the hopper to capture the majority of fish without injuring those that were not captured by the hopper. MDMR personnel will work closely with the Benton Falls operator to lessen the potential for fishway mortalities in 2009.

Discussion: After the majority of upstream migrants had occurred some observations became clear. The presence of alewives in the diffusion chamber after the installation of the 1" bar netting on both the excluder panels and the gap between the excluder panels and the super-structure was as much a mystery as it was bothersome. How did the alewives get in there? MDMR and Benton Falls personnel had spent a great deal of time observing directly the behavior of the fish in and around the fishlift facility. On one occasion, the Benton Falls operator lowered one of the surface weirs located adjacent to the exit of the fishway in the headpond. The weir was lowered to relieve the accumulation of trash around the exit of the exit flume. The weir was lowered approximately one foot setting up a strong surface flow field across the breadth of the weir. MDMR personnel on site witnessed a very large school of alewives rise from the depths immediately in front of the weir and begin to pass over the weir to the tailrace below. This observation put in place one of the final puzzle pieces to the diffusion chamber condition previously mentioned. The alewives attraction to large flows would be the driving force behind the diffusion chamber condition. Half the attraction water for the fishway entrance is derived from a draft pipe situated 10' below the surface and in immediate proximity to the exit flume for the fishway. Alewives exiting the fishway are attracted to the attraction water intake for the diffusion chamber in the entrance of the fishway and are subsequently entrained into the diffusion chamber where they tire and finally die.

Alewives that were entrained by the attraction water flow AFTER the removal of the excluder panels in the diffusion chamber stood a chance at surviving whereas those prior to the excluder panels removal were killed upon exhaustion. This condition allowed for the recycling of alewives to take place within the fishway. Alewives that had already made the approach, been captured and moved upstream and through the fish counter now stood to be counted again as they were recycled through the attraction water back to the entrance flume. No direct observations of entrainment in the attraction water were attempted through the use of video devices as getting one close enough to the attraction flow while not getting too close under the time constraints allowed was not attempted. Not long after the start-up of operations with the fishlift at Benton and the counting device did the numbers of alewives counted at Ft Halifax and the numbers counted at Benton start to diverge. The divergence of counts at Ft. Halifax and Benton Falls is discussed in the Sebasticcok River section of the report.

SEBASTICOOK RIVER –BURNHAM

Upstream passages at the Burnham dam was required to be operational one year following the installation of permanent or temporary upstream fish passage at Fort Halifax and following installation of permanent upstream fish passage at four upriver non-hydro dams. These projects included the implementation of interim upstream passage measures at Fort Halifax dam and the construction of fishways at the Pleasant Pond dam in Stetson, the Plymouth Pond dam in Plymouth, the Sebasticook Lake outlet dam in Newport, and the removal of the Guilford dam in Newport. These projects were completed on June 13, 2003, triggering a June 14, 2004 date for fish passage to be operational.

The Burnham Project submitted its final design drawings to FERC on February 14, 2005. Construction began on the Burnham Fishlift early in the summer of 2005. Despite numerous flood events, unusually high water, and setbacks construction was completed in time for the 2006 river herring run.

Narrative: Site visits to the Burnham fishlift occurred daily throughout the alewife season in 2008. MDMR personnel and the Burnham operator worked closely together to ensure effective operation of the fishlift facilities. The interim netting installed in the powerhouse tailrace had a breach prior to May 21 allowing alewives to enter the powerhouse tailrace. Alewives that entered the tailrace tended to stay there due to the attraction flow of generation. On May 21 MDMR personnel met with the Burnham operator to see if the alewives could be removed from the tailrace. Site generation was ceased and the excluder net was lifted in order to let the alewives exit the tailrace. MDMR personnel counted a thousand plus alewives exiting the tailrace. Generation at the site had been discontinued during this operation but enough water was still exiting the powerhouse to provide attraction water to alewives in the tailrace. MDMR personnel and the Burnham operator re-secured the net to prevent more alewives from entering the tailrace area. Observations conducted after the shutdown on May 22 showed the presence of an unknown number of alewives still in the tailrace (1000's).

A site visit on May 29 revealed the fishway inoperative. Closer inspection of the facility showed a mechanical fault in the crowding device. The cable link device providing power to the crowder had become entangled with the crowder and pulled itself apart. A few hours were required on site to remedy the condition and the fishlift was again operational.

Discussion: Operations at the Burnham Dam were as expected. The fishlift was operational in time for the alewife run as well as the counting tube apparatus in the exit flume. The minor mechanical failure of the crowder did not affect overall passage effectiveness. The interim net barrier located in the powerhouse tailrace still concerns MDMR. The net is susceptible to failure due to flow regimes during generation. Anchoring the net sufficiently to prevent a breach is problematic. The interim barrier is a weak point in fish passage operations at the site. The numbers of alewives that remained in the powerhouse tailrace after the breach is uncertain but the alewives were readily visible circling below the turbine outfalls. The interim net excluder needs to be re-visited and alternatives discussed. Further discussion of Burnham fishlift activities can be found in the Sebasticook River section of the report.

KENNEBEC RIVER – LOCKWOOD

Overall operations at Lockwood in 2008 went well. The lift did have to be shut down on a few occasions due to water levels or minor mechanical issues. Lockwood captured more river herring that ever before in 2008 however no shad were captured. Attraction water debris issues appear to have been resolved.

4.2 Monitoring of Down stream Fish Passage at Phase I Lake Outlets

Starting in July, MDMR personnel surveyed ten lake outlets regularly through November: Sebasticook Lake in Newport, Pleasant Pond in Stetson, Plymouth Pond in Plymouth, Wesserunsett Lake in Skowhegan, Unity Pond in Unity, Webber Pond in Vassalboro, Pattee Pond in Winslow, Threemile Pond in China, Corundal Lake in Corinna and Lovejoy Pond in Albion. The results are summarized in Table 4.1 and are briefly described below.

Sebasticook Lake outlet was checked on 25 days from July 2nd through November 20 to ensure fishway operation and adequate downstream passage. On 4 of the 25 visits downstream passage was not available.

Pleasant Pond in Stetson was visited 23 times from July 14 through Nov 20. Of those 23 visits, down stream passage was available 19 times. On 9/29 juvenile alewives were observed above the dam. Passage assessment conducted between Sebasticook Lake and Pleasant Pond reveled copious beaver activity. Only 42 adult alewives successfully passed between Sebasticook Lake and Pleasant pond in 2008. DMR made 5 trips between May 15th and June 15th to clear passage and breached numberous beaver dams several times and observed hundred's of alewives attempting to get through (Figure 4.1).

Plymouth Pond was checked on 15 days from July 14 through Novemer 20. Passage was available at Plymouth Pond on 15 of 15 visits, either through the fishway or over the crest of the dam. Juvenile alewives were observed at Plymouth Pond on July 21 and on August 15, 2008.

Wesserunset Lake in Skowhegan was surveyed 18 times from July 14 through November 20 . Passage was only available on two of those 16 visits in 2008. Passage issues also continue at the lower dam. This will be further investigated in 2009. Juvenile alewives were observed on 7/14 and on 9/29.

Unity Pond has no outlet dam and has excellent down stream passage into the Twenty-five-Mile Stream on all but the driest of years. Unity Pond outlet was checked 17 times from July 15 through November 17 and passage was available during all visits. Juvenile alewives were observed on 7/21.

Webber Pond uses a fall drawdown for water quality improvement purposes and usually has sufficient water to allow passage over the spillway throughout the season. During the 21 visits to Webber Pond, (July 14-Nov.4) passage was available 20 times. Alewives were observed on 6 occasions.

Pattee Pond has no outlet dam and in the past low water levels combined with a beaver dam obstruction during the summer and early fall made passage out of Pattee Pond difficult, if not impossible. Pattee Pond was visited 8 times and passage was available on 7 visits. No juvenile alewives were observed in the outlet stream however it is possible that no adult alewives successfully migrated into Pattee Pond in 2008.

Three-mile Pond outlet was visited 14 times between July 23 and November 17. Three-mile does not have an outlet dam however, immediately down stream of the outlet the flow enters a wide shallow heavily bushed area where passage was questionable. MDMR personnel spent time clearing passage through the bushed area to provide a passable channel. Passage was sufficient for adult alewives to migrate up from Webber Pond in the spring and successfully spawn in Three-mile Pond during the spring flows. Passage was available on 14 of the 14 visits. Juveniles were observed on 1 visit on September 30th.

4.3 Monitoring of Down stream Fish Passage at KHDG Hydropower Projects

Per Section III (F) of the Agreement, hydroelectric dam owners are required to conduct passage effectiveness studies. Specifically, the Agreement states:

"KHDG dam owners will conduct effectiveness studies of all newly constructed interim and permanent upstream and down stream fish passage facilities at project sites. Study plans for these effectiveness studies will be filed with FERC and Maine DEP no later than the date on which passage at a particular project becomes operational, and will be subject to a consultation process with, and written approval from the resource agencies."

MDMR has been working with the hydro project owners/operators to develop and evaluate quantitative and qualitative effectiveness studies. As new passage becomes available, MDMR will continue to work with hydropower project staff to ensure passage effectiveness.

To date, quantitative downstream passage effectiveness studies for juvenile alewife have been conducted at Benton Falls (1995) and Fort Halifax (1997), and qualitative assessment of downstream passage of juvenile clupeids has been conducted at the interim facilities at Lockwood, Shawmut and Hydro-Kennebec. A quantitative passage effectiveness study for juvenile alewife occured at the Burnham Project in 2007.

Down stream passage at hydropower facilities located on the Sebasticook and Kennebec Rivers were monitored through the summer and fall of 2008. Facilities were visited routinely to assess any problems that down stream migrating juveniles might encounter. The condition and operation of down stream bypass facilities, magnitude and location of spilled water, number of turbines in operation, and presence or absence of juvenile alewives were noted at each site. The dams and their locations are presented in Table 4.2; locations were illustrated earlier in Figure 4.2.

The Fort Halifax Project in Winslow is operated by FPL Energy and is the lowermost dam on the Sebasticook River. FPL Energy installed permanent down stream bypass facilities during the summer and fall of 1993; it uses the same trash sluice opening that was used in past years for the interim facility. The old trash sluice was refitted with a weir gate to control depth of flow at the entrance of the down stream bypass. The down stream side of the opening was fitted with a metal trough with an open top to carry water and fish down close to the tailrace elevation. A 12-foot deep metal punch plate trash rack overlay was installed to aid in excluding alewives from the turbine forebays. This configuration and operational regime was approved by the FERC Order issued on September 30, 1996 and was utilized again during the 2008 season.

MDMR made one visit to the Fort Halifax dam in 2008 prior to it's removal. At that time the down stream bypass was open and functioning.

The Benton Falls Project is equipped with permanent down stream passage facilities that have been on line since 1988. The bypass at Benton Falls consists of two surface weirs, one located above each turbine intake, which interconnect and discharge into the tailrace through a large diameter pipe. Water flow into each weir is regulated by a gate that can be lowered to allow controlled surface spill into the weir. After passing over this gate, fish become committed to the bypass and cannot reenter the headpond. During the 2008 season the weirs above both the large and small turbine were open.

MDMR personnel made 7 visits to make observations of down stream passage capabilities at Benton Falls in 2008 The bypass entrance was open and the facility appeared to be operating properly during each of the site visits and problems associated with debris from the headpond plugging the entrance were not observed. Juvenile alewives were observed in the Benton Falls headpond on August 11 and October 17.

MDMR personnel made 9 visits to the Burnham Project in 2008. All inspections found the down stream bypass entrance open and operating according to interim passage requirements.

Down stream passage through the bypass was available during 9 of the 9 site visits to the Pioneer dam in Pittsfield. No overlays were placed on the intake racks at the project. No juvenile alewives were observed using the down stream passage facilities on any visit.

MDMR visited the Waverly Avenue dam on 5 occasions during the 2008 season. Down stream passage was available at the site on all occasions. No overlay was installed on the intake racks in 2008.

MDMR visited both the Lockwood and Hydro-Kennebec dams as often as possible in 2008. Both of these projects are located on the Kennebec River and must pass all down stream migrant alewives from the Wesserunset Lake alewife restoration effort. Additionally, all of the larval shad, released into the Kennebec River are released above both Lockwood and Hydro-Kennebec. In 2008 there were also 22 adult Atlantic Salmon transferred from the Lockwood fishway to the Sandy River, a tributary of the Kennebec. Additionally 106 prespwan Domestic salmon were released into the sandy river. These adults also had to navigate Lockwood and Hydro-Kennebec facilities on there return trip to the ocean after spawning. During the 2008 season, interim down stream passage at Lockwood was made available through the power canal trash sluice, which is located near the turbine trash racks. Hydro-Kennebec's downstream passage consists of a floating 10 ft deep, angled, fish guidance boom located in the powerhouse forbay. This boom directs migrants to a 4' x 8' ft deep gated surface bypass with a max flow of 320 CFS and discharges migrants into a plunge pool which then dumps into the projects tailrace.

4.4 Cobbosseecontee Stream Fish Passage

The Department of Marine Resources is in the process of developing a Diadromous Fish Restoration Plan for the Cobbosseecontee Stream watershed. Presently, the draft is being reviewed within the Department, after which it will be forwarded to IF&W for review. Both MDMR and the USFWS have approved interim plans for down stream fish passage in the form of a flashboard notch and plunge pool. At the current stocking density in Pleasant Pond (the only waterbody in the watershed presently stocked with adult alewives) and resulting alewife offspring production, this bypass method has been successful the past five seasons.

In 2008 the plunge pool was reinstalled as well as the punch plate, (extending from the bottom to within eight feet of the surface), at the American Tissue Project on Cobbosseecontee Stream. A few dead eels were noted noted during multiple site visits in 2008. In conjunction with the punch plate, the deep gate was opened and appeared to successfully pass eels. Alewives appeared to use the plunge pool successfully as none were noted dead or injured below the project site.

Figure 4.1 Beaver Dam blocking Passage between Sebasticook Lake and Pleasant Pond in Stetson

Figure 4.2 Kennebec River Restoration Study Area

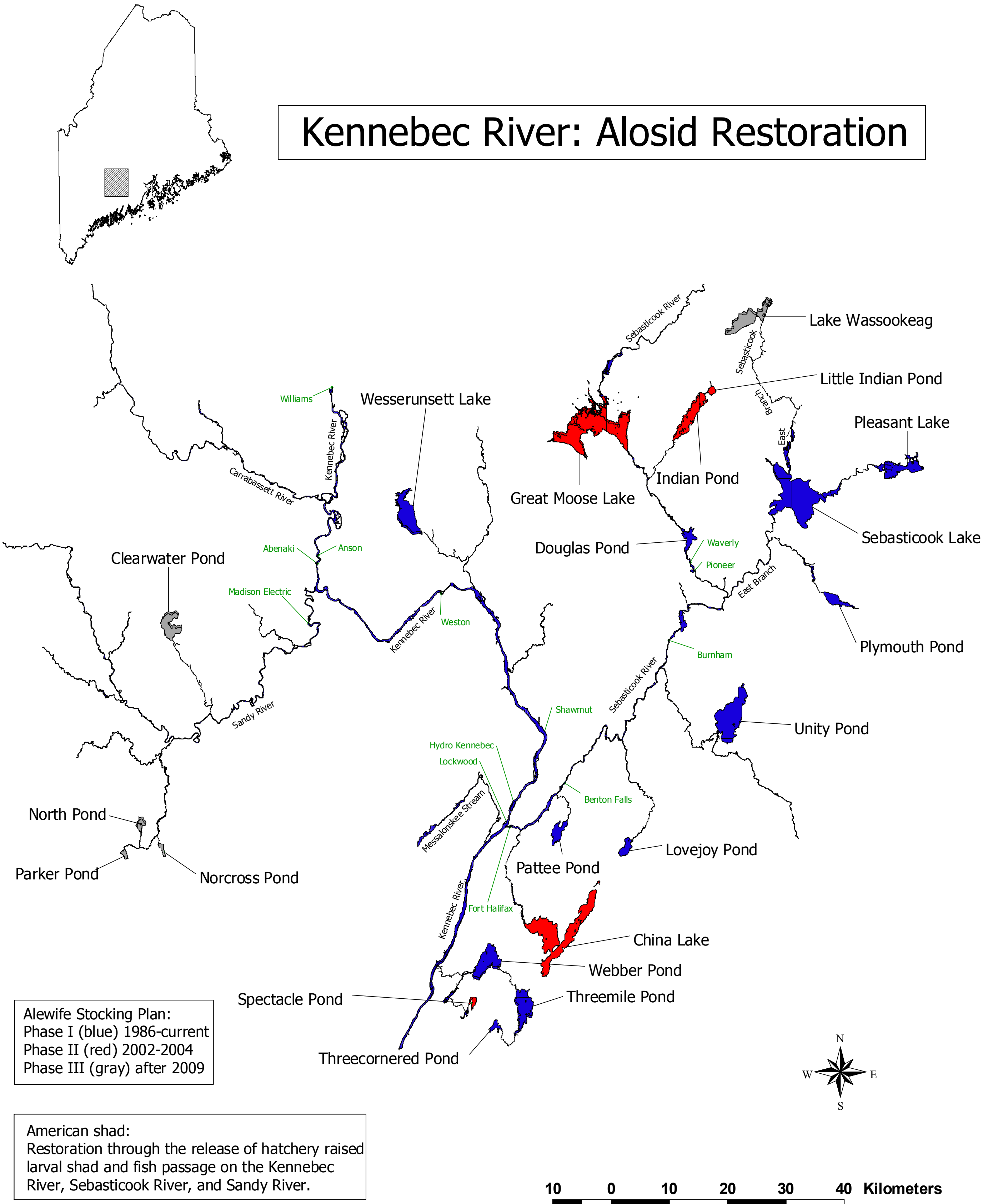

Table 4.1 Downstream Passage Observations of Juvenile Alewives at Lake Outlets in Sebasticook and Upper Kennebec Watersheds, 2008.

Date	Sebasticook Lake	Plymouth Pond	Unity Pond	Pleasant Pond	Pattee Pond	Webber Pond	Threemile Pond	Wesserunsett Lake	Corundal Lake
7/2/2008	O								
7/10/2008	O								
7/14/2008	O	O		O		O^{A}		X^{A}	X
7/15/2008	O		O		O				
7/21/2008	O	O^{U}	O^{U}	O				O	O
7/23/2008	O			O	O	O	O		
8/5/2008	O		O	O	O	O	O	O	O
8/11/2008	O		O	O	O			O	
8/12/2008	O	O				O	O		O
8/15/2008	O	O^{A}	O	O				O	O
8/20/2008						O			
8/22/2008	O		O	O				O	
8/25/2008	O			O				O	
8/26/2008						O	O		
8/29/2008	O	O	O	O		O^{A}		O	X
9/4/2008	X	O		O		O		X	X
9/9/2008	O			X		X^{U}			
9/10/2008						O^{B}	O		
9/11/2008						O^{B}	O		
9/15/2008	O	O	O	X		O	O	O	O
9/17/2008	O		O	O	O	O			
9/24/2008	O	O	O	X		O	O	O	
9/26/2008				X			O		
9/29/2008	O	O	O	O^{A}		O		O^{U}	
9/30/2008							O^{U}		
10/3/2008	O		O	O		O	O		
10/8/2008	O	O		O		O^{B}		O	O
10/13/2008					O				
10/15/2008	O	O	O	O		O	O	O	
10/23/2008	X		O		X	O			
10/24/2008		O		O			O	O	O
10/29/2008	X	O	O	O		O		O	O
11/4/2008		O	O	O		O		O	X
11/17/2008			O		O		O		
11/20/2008	X	O		O				O	X
Total Visits	25	15	17	23	8	21	14	18	13
Passage	21	15	17	19	7	20	14	16	8
No Passage	4	0	0	4	1	1	0	2	5

O = Downstream passage available at time of survey
X = Downstream passage not available at time of survey
= Not surveyed on this day
^{U} = Juvenile alosids passing downstream
^{A} = Juvenile alosids above outlet
^{B} = Live alosids present below outlet
^{D} = Dead alosids present below outlet

Table 4.2. Downstream Passage Observations at Hydroelectric Facilities, 2008

Date	Fort Halifax	Benton Falls	Burnham	Pioneer	Waverly
7/14/2008	O				
7/15/2008		O	O	O	
7/23/2008		O	O	O	O
8/5/2008			O	O	
8/11/2008		O[H]		O	
8/12/2008			O		
9/4/2008			O	O	O
9/17/2008		O[H]	O	O	O
9/29/2008			O		
10/23/2008		O	O	O	O
11/4/2008		O		O	
11/17/2008		O	O	O	O
Total Visits	**1**	**7**	**9**	**9**	**5**
Passage	**1**	**7**	**9**	**9**	**5**
No Passage	**0**	**0**	**0**	**0**	**0**

O = Downstream passage available at time of survey
X = Downstream passage not available at time of survey
= Not surveyed on this day
H = Juvenile alosids in headpond

KHDG
Fish Community Assessment

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MDMR personnel conducted biweekly beach seine surveys at eight sites in the Kennebec River between Augusta and Waterville. A total of 11 seine hauls were made. A total of 11 juvenile alewives, 699 juvenile American shad were captured. The catch/effort for juvenile shad was 63.55, compared to 192.00 in 2007.

Introduction

With the removal of the Edwards dam in 1999, approximately 17 miles of Kennebec River habitat was reopened for the first time since the dam was built in the mid-1800s. The benefits of dam removal are already being realized with anecdotal reports of enhanced recreational angling opportunities and results, as well as an increase in available spawning and nursery habitat for native anadromous fish species. For example, evidence of American shad spawning has occurred as far upriver as Winslow. In addition, both striped bass and sturgeon are now observed in Winslow. There are also increased observations of wildlife species benefiting from this newly opened river stretch. MDMR staff have observed bald eagles, osprey, great blue heron, several species of ducks and Canada geese, as well as various species of aquatic furbearers, including mink and river otter, and even a harbor seal, utilizing this free-flowing segment of the Kennebec.

The intent of this investigation is to document the presence and spawning activity of anadromous fish species (e.g., American shad, blueback herring, and rainbow smelt) in this newly reopened stretch of river. This data will be useful to examine the impact current restoration programs are having on Kennebec River stocks of anadromous fish. Additionally, habitat information will be collected at each fish sample site. Data will be used to document changes in habitat types over time and determine how these changes will benefit anadromous fish.

SAMPLING SITES

In June 2000, Kennebec River Project personnel surveyed the 17-mile stretch of the Kennebec River from the Fort Halifax and Lockwood dams down stream to the former Edwards dam site. The objective of the survey was to locate potential sampling sites for the deployment of beach seines and other sampling gear for fish community assessment purposes. Several factors led to the selection (or non-selection) of the sampling sites, including depth; areas of strong currents; and obstructions such as ledges, logs and boulders, which render potential sites unsuitable for seining and fyke net deployment. Generally, sites with even, regular bottoms were chosen. Originally, a total of eight sites were sampled biweekly between Waterville and Augusta from June/July (immediately following alewife/shad stocking) until November.

BIOLOGICAL SAMPLING PROCEDURES

Depending on river flow, either a 17-foot or a 19-foot johnboat equipped with a jet drive was used to access all of the sampling sites. At sites where water depth exceeded the ability to wade, the johnboat was used to deploy an 8' x 150' x 3/8" delta mesh net with an 8' x 8' x 8' x ¼" delta mesh bag seine. The bag was used to better capture and, more importantly, retain the items sampled by eliminating the gap between the net and river bottom at the vertex of the seine as it was hauled. The beach seine was flaked onto the bow of the boat. After landing at the survey site, a crewmember would debark and hold one end of the beach seine. The boat would then be backed out into the river and continue until approximately 2/3 of the net had been deployed. At this point, the boat would back towards shore. As the boat reached wading depth, a crewmember would debark, taking the other end of the net to shore where the haul would be completed.

In order to best understand the structure of the fish community present, every species of fish both diadromous and resident were examined. Total number of fish caught was assessed, as was number per species. Total length was assessed to the nearest millimeter for up to 50 diadromous fish per species and up to 10 per resident species. If American shad were captured a random sample was placed on ice and brought back to the MDMR office in Hallowell for otolith work (see Section 3.0 of this report).

DATA ANALYSIS

Seining surveys for the 2008 season commenced on July 16. The sampling sites consisted of the same sites as those of late 2002.

A total of 11 seine hauls were made during the community assessment survey on the Kennebec River upstream of the site of the former Edwards dam. A total of 1,236 fish representing 11 species were captured and identified. Of those, total length was assessed for 309 fish. Fish of questionable identity were placed on ice for later identification. For a breakdown of diadromous fish captured by site, refer to Table 5.1.

Due to high river flows throughout the summer of 2008, our seining effort was curtailed for safety reasons. Flows in the Kennebec River July through October were rarely below the USGS 22 year mean daily static and our safety cutoff of approximately 6000 CFS (Figure 5.1). DMR only made 2 trips on the upper river in 2008 with only one full round of seining. Generally we seine all sites 6+ times per season.

Figure 5.1 USGS Daily Discharge for Kennebec River at North Sidney demonstrating MEDMR seining safety cutoff

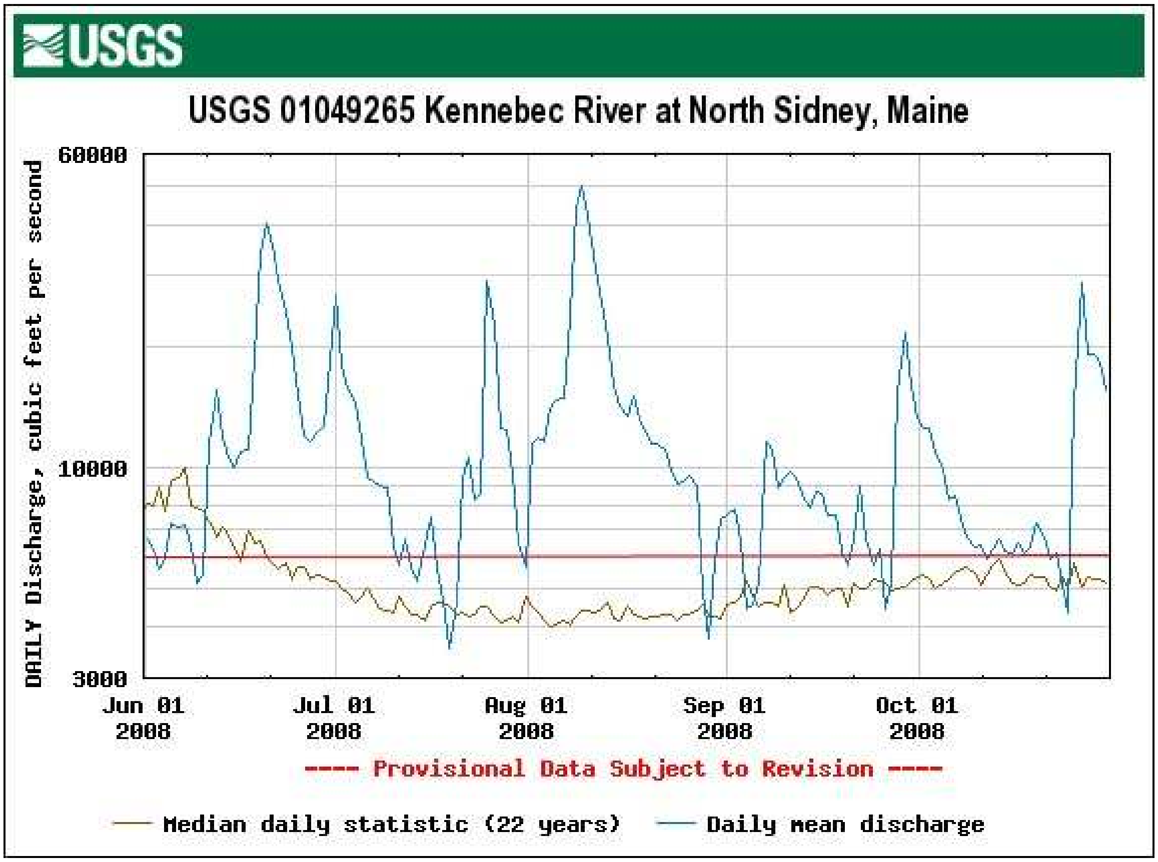

Table 5.1 Diadromous Fish Captured in the Kennebec River above the Edwards Dam Site, 2008

Species	Site 1	Site 2	Site 3	Site 4	Site 5	Site 7	Site 8B	Site 8C
Alewife	0	0	0	6	0	0	1	4
American Eel	0	0	0	0	0	0	0	0
American Shad	0	1	0	0	0	10	266	392
Blueback Herring	0	0	0	0	0	0	0	0
Striped Bass	0	0	0	0	0	0	0	0
Site Totals	**0**	**1**	**0**	**6**	**0**	**10**	**267**	**396**
Grand Total All Sites	**680**							

Total By Species	
Alewife	**11**
American Eel	**0**
American Shad	**669**
Blueback Herring	**0**
Striped Bass	**0**

KHDG

Upstream eel passage in the Kennebec River watershed

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Executive Summary

DMR obtained data on upstream eel passage at three hydropower projects in the watershed. An estimated 76,881 eels passed Fort Halifax in 18 days; 18,395 passed Benton Falls in 85 days; and 26 passed Anson in 4 days.

Interim downstream passage measures designed specifically for American eel were operational at two KHDG projects (Benton Falls and Burnham) and three other projects in the watershed (Anson, Abenaki, and American Tissue). At the remaining five KHDG projects, interim downstream passage measures designed for anadromous species were operational. Quantitative or qualitative effectiveness testing for some mainstem projects was continued in 2008.

Upstream eel passage in the Kennebec River watershed

INTRODUCTION

Juvenile eels migrate into Maine's coastal waters in the spring. Some juveniles remain in estuarine habitat, but many attempt to migrate to growth habitat in inland waters. Man-made obstacles, such as dams, may prevent or delay the upstream migration. The Atlantic States Marine Fisheries Commission's *Interstate Fishery Management Plan for American Eel*, adopted in 2000, calls for 1) maintaining and enhancing eel abundance in all watersheds where they now occur, 2) restoring eels to waters where they had historical presence but may now be absent, and 3) providing adequate upstream passage and escapement into inland waters of elvers and eels. Improving passage at dams and other barriers must be improved to accomplish these goals.

During the Federal Energy Regulatory Commission (FERC) licensing process, the owner of a hydropower facility consults with resource agencies to determine appropriate fish passage measures. Once the license is issued, the operating conditions are fixed for the licensing period, typically 30-50 years. Since 1997, DMR has been requesting upstream and downstream passage for eels at appropriate hydropower projects during the licensing process.

Beginning in 1998, DMR conducted field studies or consulted with hydropower owners to determine where upstream eel passage should be located at 10 hydropower projects in the lower Kennebec Basin.
Permanent[4] upstream eel passage has been installed at six of the seven Kennebec Hydro-Developers Group (KHDG) projects and at the Anson Project (Fig. 6.1) pursuant to the project licenses. Upstream passage at the remaining KHDG project (Burnham) is expected to be installed in 2009. After consultation with the resource agencies, Madison Paper removed some ledge in the Abenaki Project bypass in 2008 to improve eel passage. An additional season of study is needed to determine where the upstream passage should be situated at the spillway (the previously selected site was inundated with gravel in the winter of 2008).

In 2008, DMR continued to monitor upstream eel passage and recruitment at two projects on the Sebasticook River and one on the mainstem.

METHODS

Migrating eels were collected in traps at the upstream end of permanent or interim upstream eel passage facilities at each of three hydropower projects. DMR enumerated all eels that were passed upstream, and collected length and weight information on subsamples. In general, the passages were operated seven days per week, and were tended at least twice per week. If the

[4] "Permanent" upstream eel passage is installed each spring and removed each fall by project owners to prevent damage from high flows and ice. Target operational dates for upstream eel passage on the Kennebec River are June 1 to September 15; however, installation may be delayed by high flows and removal may be expedited if heavy fall rains are forecast.

number of eels captured at a project was less than 70, all eels were counted and total weight recorded. If catches exceeded 70, all eels were weighed and the number estimated from subsamples. Eels were released above each dam into the headpond after measurements were taken.

RESULTS AND DISCUSSION

Eel passage at the **Ft. Halifax Project** became operational in June after fresh water discharge on the Sebasticook River and mainstem Kennebec River started to decline (Fig. 6.2). The passage operated for 18 days between 6/3 and 7/2, passed an estimated 76,881eels (Table 6.1), and was removed in early July prior to dewatering of the headpond and removal of the Fort Halifax dam[5]. Eels ranged from 85-187 mm total length (TL). The length distribution of eels at Fort Halifax has been fairly consistent during the ten years of passage with the exception of 2004 and 2005 (Fig. 6.3) when a large number of eels greater than 150 mm were passed.

Eel passage at the **Benton Falls Project** became operational on 6/12. No eels were captured until 6/19, but migrants could have escaped in the intervening week through a small hole in the trap. The passage operated for 85 days, and passed an estimated 18,395 eels (Table 6.1). However, most of the eels passed upstream within the first month. Eels ranged from 86-222 mm TL (Fig. 6.4).

The Anson Project upstream eel passage was damaged in 2007, and was rebuilt for the 2008 passage season. It became operational on 7/21, and was shut down on 8/1. Due to high flows (Fig. 6.2), the passage was effective on four of the 12 days it operated. During this period, 26 eels, which ranged from 108 to 172 mm TL, were passed upstream.

Downstream eel passage in the Kennebec River watershed

INTRODUCTION

Adult eels, known as silver eels, migrate in late summer and fall from Maine's inland waters to the sea to spawn. The Atlantic States Marine Fisheries Commission's *Interstate Fishery Management Plan for American Eel*, adopted in 2000, calls for 1) maintaining and enhancing eel abundance in all watersheds where they now occur, 2) restoring eels to waters where they had historical presence but may now be absent, and 3) providing adequate escapement to the ocean of prespawning adult eels. Migration of eels past dams and other obstacles must be improved to accomplish these goals.

During the Federal Energy Regulatory Commission (FERC) licensing process, the owner of a hydropower facility consults with resource agencies to determine appropriate fish passage measures. Once the license is issued, the operating conditions are fixed for the licensing period, typically 30-50 years. Since 1997, DMR has been requesting upstream and downstream passage for eels at appropriate hydropower projects during the licensing process.

[5] Removal of Fort Halifax Dam was initiated in August and completed on October 31, 2008.

Results and Discussion

Freshwater discharge in the Kennebec watershed during the summer and fall of 2008 was generally well above median values (Fig. 6.2).

In 2008, interim downstream passage measures designed specifically for American eel were operational at two KHDG projects (Benton Falls and Burnham) and three other projects in the watershed (Anson, Abenaki, and American Tissue). These measures include full-depth screening (one-inch clear space or one-inch punch plate) of the turbine intakes and bypass flows through surface or bottom opening gates. At the remaining five KHDG projects interim downstream passage measures designed for anadromous species were operational. These measures include surface screening of the turbine intakes and bypass flows through surface opening gates.

Quantitative assessment of downstream passage measures was conducted in 2008 by FLP Energy at the Lockwood and Shawmut projects, and qualitative assessment was conducted by Brookfield Power at the Hydro-Kennebec Project.

Table 6.1. Upstream eel passage at hydropower projects in the Kennebec River watershed, 1999-2008.

Project	Year	Startup date	Shutdown date	Operating days	Eels passed
Anson	2006	7/14	8/31	49	26
	2007	7/19	9/7	51	355
	2008	7/21	8/1	4	26
Benton Falls	1999*	6/22	9/16	61	14,013
	2000*	6/30	9/5	44	37,987
	2001*	6/6	8/24	55	229,536
	2002	6/18	9/13	53	22,437
	2003	6/26	9/2	15	6,421
	2004	7/15	8/12	29	2,409
	2005	7/13	8/29	38	469
	2006	6/30	8/30	57	522
	2007	7/13	8/31	38	546
	2008	6/12	9/8	85	18,395
Fort Halifax	1999*	6/4	9/15	80	473,273
	2000	6/19	8/29	59	71,879
	2001	5/26	8/24	89	223,184
	2002	6/10	9/13	75	56,376
	2003	6/11	9/11	50	154,624
	2004	6/28	9/1	40	67,217
	2005	6/28	8/29	44	7,818
	2006	7/28	8/30	27	43,755
	2007	6/6	8/31	91	38,869
	2008	6/3	7/2	18	76,881

Figure 6.1. Location of hydropower projects and fishways within the Kennebec River watershed.
KHDG hydropower projects indicated by star (*), hydropower projects that have been removed by two stars (**), other hydropower projects by plus (+), and nonhydropower dams have no symbol. Figure has not been updated to reflect removal of Fort Halifax Dam in late 2008.

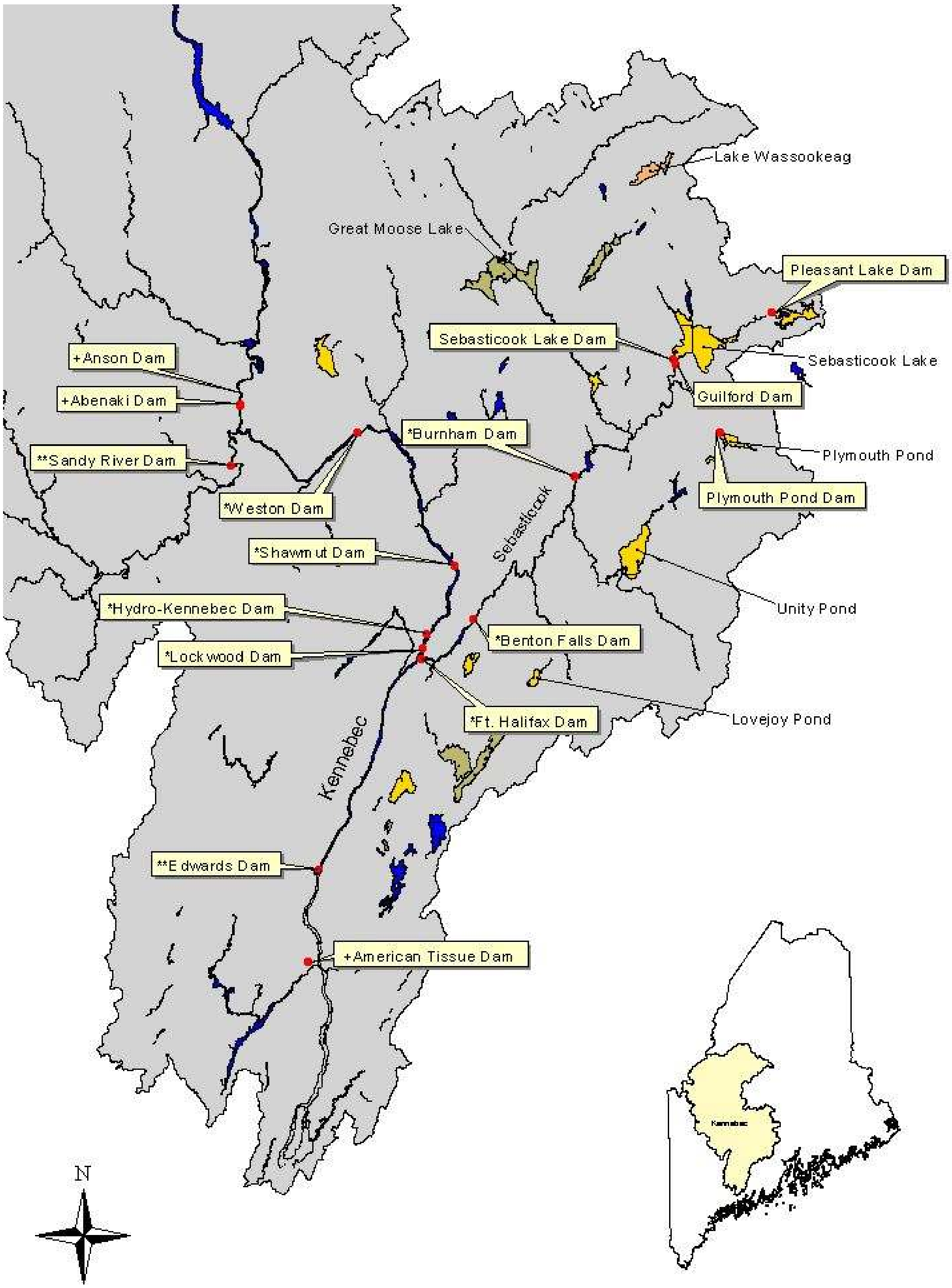


Figure 6.2. Provisional streamflow on the Sebasticook River in 2008.

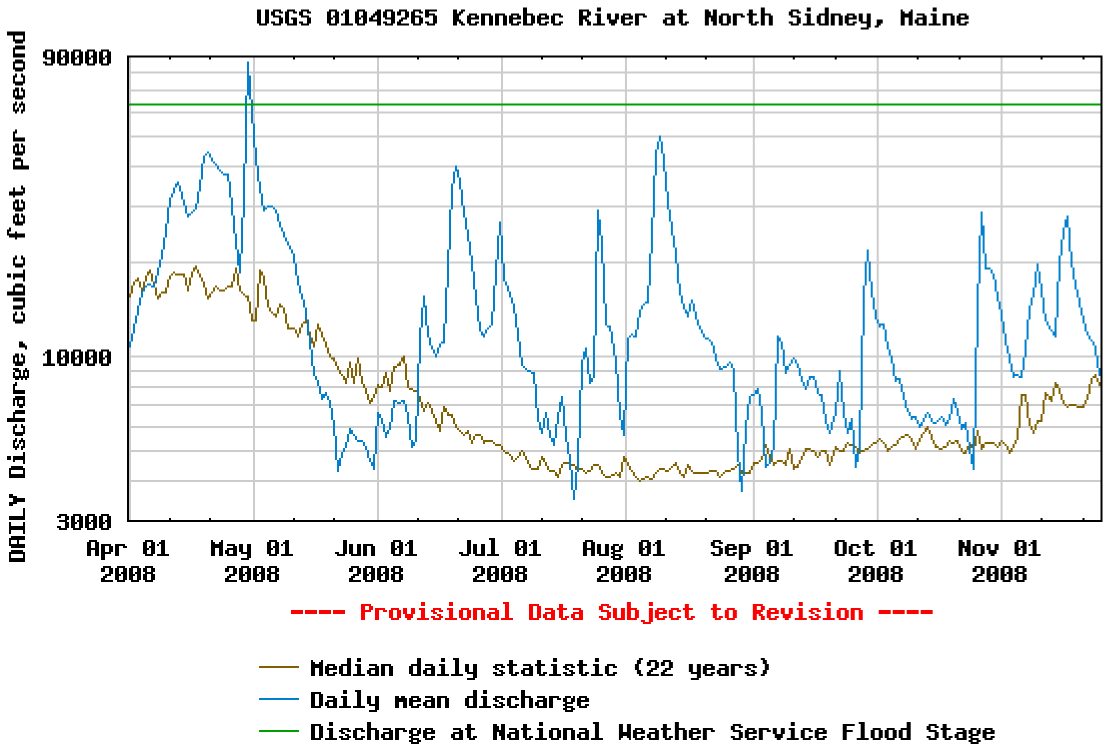


Figure 6.3. Box plots of total length of eels passed at the Ft. Halifax Project, 1998-2008.

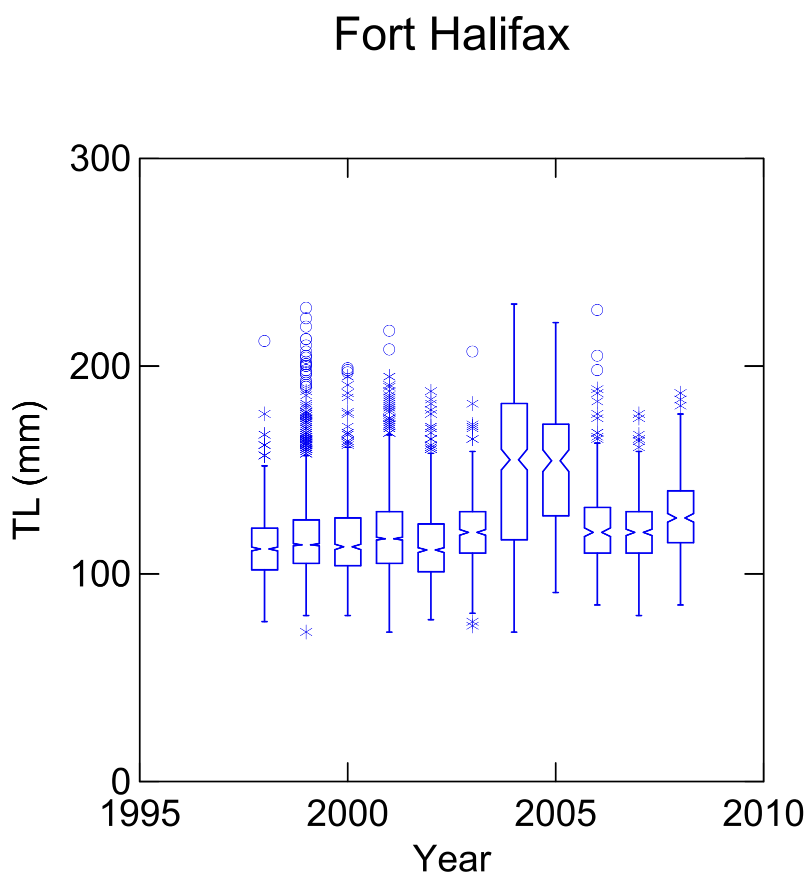
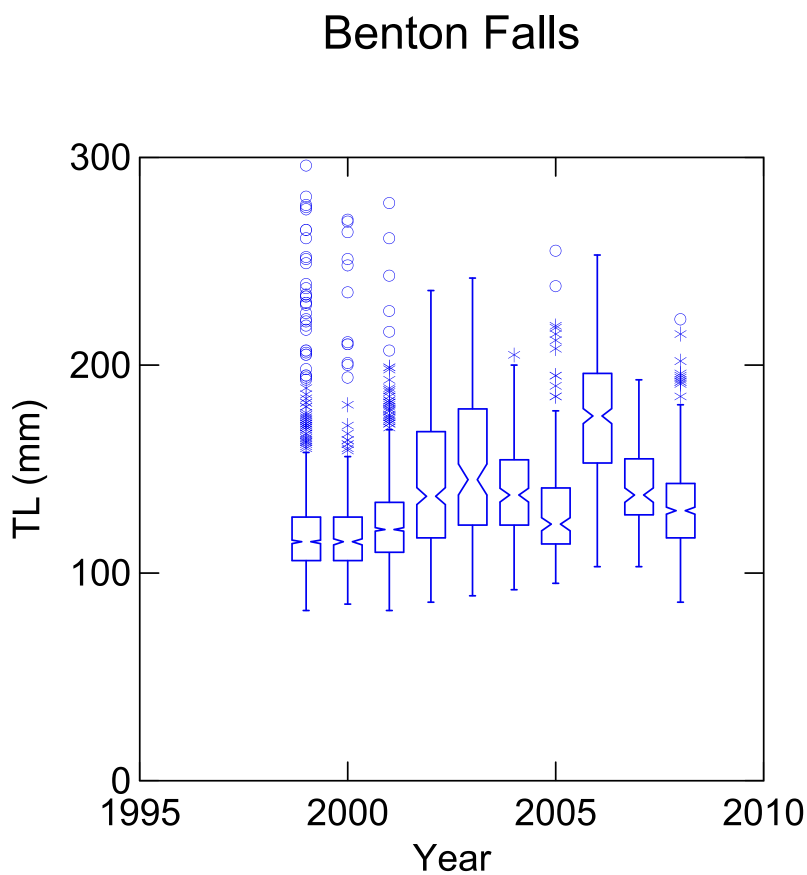


Figure 6.4. Box plots of total length of eels passed at the Benton Falls Project, 1999-2007.



KHDG

ATLANTIC SALMON RESTORATION

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Executive Summary

The Lockwood Project fishlift in Waterville became operational in May and captured the first Atlantic salmon (ATS) on June 3rd. A total of 22 adult ATS were captured and translocated to the Sandy River and released into appropriate spawning and juvenile nursery habitat. Eight of the captured fish were one sea-winter returns and 14 were multi sea-winter returns. Eight of the returning fish were of naturally reared origin and 14 were hatchery origin fish, released as smolts in other drainages.

Population estimates were conducted via electrofishing at 42 sites in the Kennebec River drainage. No salmon were found in Bond Brook and Togus Stream. Electrofishing results from the Sandy River indicate that juveniles were present in areas where they were released as either eggs or fry. In addition, juvenile ATS were found at nine locations in the Sandy River drainage that could not have come from stocking efforts. These fish were the product of natural spawning from ATS translocated from the Lockwood Project fishlift to the Sandy River in 2006 and 2007.

Spawning surveys were conducted to estimate the number of returning adults, and determine the locations of redds made by sea-run and domestic adults. A total of 22 surveys were conducted. Surveys were unsuccessful at locating any redds in Bond Brook or Togus Stream. However, eight redds were found in the Sandy River drainage. Four redds were presumed by their location and radio telemetry data to be the product of sea-run ATS and four redds were presumed to be from the fall domestic adult stocking. Extreme high flow events in November 2008 hampered these efforts, removing any trace of previously created redds or test pits on a number of occasions. The mainstem Kennebec River was not surveyed in 2008 due to high flows.

A limited temperature monitoring effort was made in 2008. Temperature loggers were placed in the Sandy River drainage to monitor spring and summer temperatures around four egg planting research sites.

All juvenile releases in 2008 were the result of an ongoing hydraulic egg-planting research project conducted in the Sandy River drainage. Eggs were planted with a hydraulic egg planter to investigate the use of green and eyed eggs as a viable tool for ATS restoration. Approximately 240,000 eggs were divided and buried in eight locations for this project in 2007. Seven artificial redds were covered with fry traps to capture alevin and determine emergence success, while other sites were sampled via electrofishing in the fall. Alevin were produced with variable success at most sites.

An adult ATS radio telemetry project that began in 2007 to assess the translocation success of adult ATS captured at the Lockwood Project fishlift continued in 2008. Nine of the captured salmon were tagged and tracked intermittently throughout the summer and fall. Eight of the nine tagged multi sea-winter ATS remained in the Sandy River through the spawning season. One tagged fish dropped down into the mainstem Kennebec River and never was detected in the Sandy River again. Ten domestic adult

ATS were also tagged prior to their release in the Sandy River and tracked in the fall of 2008. The majority of these fish showed considerable downstream movement throughout the fall of 2008, and none of these fish were ever detected above their release site in Avon. The radio telemetry study documented adult ATS holding areas, movements and enabled biologists to concentrate redd count efforts.

ATLANTIC SALMON RESTORATION

Field activities conducted by the DMR staff consisted of the following in 2008: adult translocation from the Lockwood Fishlift, juvenile salmon population assessments, spawning surveys, habitat assessments, temperature monitoring, and instream incubation.

ADULT TRAPPING

Methods

The fishlift at the Lockwood Project was operational for the majority of the season between May and November, except during periods of extreme high flows, emergency fishlift maintenance, and high river temperatures. DMR staff transported all captured adult Atlantic salmon to the Sandy River.

Results and Discussion

A total of 22 adult Atlantic salmon were captured at the fishlift and transported to the Sandy River, and all were released alive. Eight of the captured fish were one sea-winter (grilse) returns and 14 were two sea-winter returns. A breakdown of the age, origin, and sex of the captured fish are outlined in Table 7.1.

ATLANTIC SALMON POPULATION MONITORING

JUVENILE ATLANTIC SALMON ASSESSMENTS

Methods

DMR crews sampled a total of four sites in Bond brook and Togus stream to determine the presence or absence of juvenile Atlantic salmon. Additionally, 38 sites were sampled in the Sandy River drainage to assess survival and growth of fry released from streamside incubators and instream incubation efforts in 2006 and 2007. Electrofishing was also conducted in discrete locations in the Sandy River drainage to document potential adult Atlantic salmon spawning in 2007. Captured Atlantic salmon were sampled for length and weight, according to DMR electrofishing protocols. A small proportion of the captured Atlantic salmon parr also had a small sample of scales removed for age determination.

Results and Discussion

No Atlantic salmon were found in Bond Brook or Togus Stream. In most areas where juveniles were released in the Sandy River drainage as either eggs or fry, juveniles were found during electrofishing efforts (Table 7.2). DMR staff also found young of the year (yoy) salmon in areas not receiving fry or eggs. These salmon could only have come from the natural spawning of adults translocated to the Sandy River in 2007. Electrofishing data from 2007 is also represented in the table.

SPAWNING SURVEYS

Methods

Two redd counts were undertaken by foot on Bond Brook and Togus Stream. 20 redd count surveys were completed in the Sandy River drainage to evaluate the spawning success of adult Atlantic salmon translocated to the Sandy River from the Lockwood Facility fishlift. No survey was conducted on Messalonskee Stream or the mainstem Kennebec River due to extremely high water.

Results and Discussion

We were unable to document any redds in either Bond brook or Togus stream. However, eight redds were documented in the Sandy River drainage. Four redds were presumed by their location and telemetry data to be the product of the sea-run adult ATS and four redds were presumed to be the product of adult domestic ATS stocked into the Sandy River in the fall of 2008.

TEMPERATURE MONITORING

Methods

Data loggers were deployed and set to record temperatures once every hour in the Sandy River in four locations to document spring and summer temperatures around experimental hydraulic egg planting sites. Temperature loggers were deployed in Cottle Brook, Orbeton Stream, the Sandy River, and Perham Stream in May of 2008 and were retrieved in October.

Results and Discussion

The 2008 temperature data is being processed and will be available by request in the summer of 2009.

Research

INSTREAM INCUBATION

Methods

DMR undertook various instream incubation projects between the fall of 2003 and 2008, specifically aimed at developing a restoration program with limited hatchery dependence.

This work continued in 2008 with the evaluation of the hydraulic egg planter and planting techniques. In 2008, a total of 106,000 green and 60,000 eyed ATS eggs were planted into five areas in the Sandy River drainage.

Results and Discussion

Fry traps and fall electrofishing will be utilized to estimate alevin emergence and survival from artificially created redds in 2009. A report for the 2008/2009 project will be compiled and available in the fall of 2009. The report of the 2007/2008 instream incubation project is attached. (Appendix D).

ADULT TELEMETRY

Methods

DMR staff initiated a multi-year radio telemetry project in 2007 to assess the trap and truck program. The projects goal was to determine if adult Atlantic salmon translocated to the Sandy River would remain in the Sandy River through the spawning season. The project consisted of implanting radio tags into adult Atlantic salmon when they were captured at the Lockwood Facility fishlift. These fish were then trucked and released into the Sandy River. Nine of the 22 salmon captured at the Lockwood Facility fishlift were tagged and manually tracked throughout the summer, fall and winter of 2008. The 2008 telemetry project also included the addition of three fixed telemetry receivers and antennas placed at the Weston and Lockwood facilities, and in the town of Farmingdale. In addition, ten tags were implanted into domestic adult ATS stocked into the Sandy River in the fall of 2008 to assess river fidelity, spawning locations, and potential spawning success. The report from the 2007/2008 tracking season is attached as appendix F.

Results and Discussion

Preliminary data indicates that the vast majority of the tagged sea-run ATS remained close to the Sandy River release site in Phillips throughout the spawning season. Eight of the nine tagged multi sea-winter ATS remained in the Sandy River through the spawning season. One tagged fish dropped down into the mainstem Kennebec River and never was detected in the Sandy River again. This fish was detected in the Kennebec River at Sidney on January 27th, 2009 and had moved a total of 164 km downstream since its release on June 3rd, 2008. Ten domestic adult ATS were also tagged and tracked in the fall of 2008. The majority of these fish showed considerable downstream movement throughout the fall of 2008, and none of these fish were ever detected above their release site in Avon. Telemetry data from the 2007/2008 tracking season was used to prioritize redd count surveys to areas where tagged fish were known to be. A full report of the project is currently being written and will be available in the spring of 2009.

ATLANTIC SALMON RELESAES

JUVENILES

Methods
All juvenile releases in 2008 were the product of instream incubation research conducted in the fall and winter of 2007. Green and eyed fertilized eggs were hydraulically planted into the appropriate substrate in the winter of 2007.

Results and Discussion
In 2007, green and eyed eggs were planted as part of an ongoing instream incubation research project. Eggs were planted with a hydraulic egg planter to investigate the use of green and eyed eggs as a viable tool for ATS restoration. Approximately 240,000 eggs were divided and buried in eight locations for this project in 2007. Three sites were in the mainstem Sandy River above Avon, and five sites were in upper Sandy River tributaries. Seven artificial redds were covered with fry traps to capture alevin and determine emergence success, while other sites were sampled via electrofishing in the fall. Alevin were produced with variable success at most sites. The report of the 2007/2008 instream incubation project is attached (Appendix D).

ADULT DOMESTIC

Methods

106 domestic adult ATS were stocked into the Sandy River in Avon in October 2008 in order to increase natural spawning in the drainage. These fish were of Penobscot River origin and were retired broodstock from the USDA Aquaculture Research Facility in Franklin. Some of these adults were first time spawners and some were rejuvenated after spawning in 2007. These adults were transferred to Cook Aquaculture in Bingham in the winter of 2007/2008, and released into the Sandy River at the time they were believed to be ready to spawn. Ten females had radio tags implanted into them before release in order to guide redd count surveys and to evaluate movements.

Results and Discussion

Preliminary telemetry data shows that most of these fish exhibited significant downstream movement after release, and that no tagged fish moved upstream of the release location. Redd counts were able to locate four redds and several test pits created by these domestic adults. Several extreme high flow events in the fall removed any sign of previously constructed redds, and limited the number of redd count surveys for safety and efficiency reasons. Electrofishing in the fall of 2009 will help determine the contribution of these adults to the juvenile ATS population in the Sandy River. All Atlantic salmon stocking is summarized in Table 7.3.

Table 7.1 Adult Atlantic Salmon Captured at the Lockwood Fishlift and translocated to the Sandy River, 2008.

Date	Age *	Sex	Origin**
06/03/2008	2SW	F	H
06/11/2008	2SW	F	W
06/17/2008	2SW	M	W
06/27/2008	2SW	M	H
06/27/2008	2SW	F	H
07/07/2008	1SW	G	H
07/12/2008	2SW	M	H
07/10/2008	2SW	F	W
07/15/2008	1SW	G	H
07/17/2008	2SW	F	W
07/17/2008	2SW	M	H
07/19/2008	1SW	G	H
07/21/2008	2SW	F	W
07/22/2008	1SW	G	H
07/24/2008	2SW	M	W
07/30/2008	1SW	G	H
07/30/2008	2SW	F	W
07/30/2008	1SW	G	H
07/30/2008	2SW	Unk	H
07/30/2008	1SW	G	H
09/09/2008	2SW	M	H
10/01/2008	2SW	M	W

* 1SW denotes a one sea-winter fish, 2SW denotes a two sea-winter fish and 3SW denotes three sea-winters.

** W denotes naturally reared either wild or fry stocked, H denotes hatchery origin

Table 7.2 Electrofishing data from sites where juveniles Atlantic salmon were found in 2007 and 2008. YOY denotes young of the year.

Distance Up Stream (KM)	SiteName	LifeStage	Number	Avg. Fork Length (mm)	LifeStage	Number	Avg. Fork Length (mm)
2007							
Sandy River							
105.93	Log yard riffle	parr	1	162			
103.79	Above old bridge abuttments	parr	1	168			
103.23	Above Bean property				yoy	1	82
101.87	Above Saddleback stream	parr	2	155	yoy	1	84
100.76	Below Saddleback stream	parr	2	140			
100.89	1st site below Madrid Index	parr	7	122			
100.57	1st site above Madrid Index	parr	13	127			
100.52	Madrid Index	parr	9	122	yoy	2	77
100.23	Guy Hudson property	parr	6	123	yoy	1	73
99.37	Madrid pool #4	parr	4	142			
98.95	Madrid pool				yoy	5	72
98.78	Madrid pool #2				yoy	10	76
98.53	Madrid pool #3				yoy	5	71
98.26	Twin bridges	parr	1	111			
94.35	Echo Valley Lodge				yoy	1	70
South Branch Sandy River							
0.16	Site 1				yoy	1	n/a
0.26	Site 2				yoy	2	n/a
0.36	Site 3				yoy	1	n/a
0.48	Site 4				yoy	4	n/a
0.7	Site 5				yoy	26	n/a
0.86	Site 6				yoy	14	n/a
0.97	Site 7				yoy	12	n/a
1.24	Site 8				yoy	6	n/a
Orbeton Stream							
11.99	Hemlock Riffle	parr	3	136			
11.2	Cedar Bottom	parr	1	146	yoy	3	66
1.05	Echo Valley Road #2				yoy	2	61
0.9	Echo Valley Road				yoy	1	65
0.77	Echo Valley Road #4				yoy	1	63

Perham Stream							
6.05	Upper Perham #5				yoy	15	66
5.89	Upper Perham #4				yoy	4	72
4.71	Upper Perham #2				yoy	16	66
4.49	Upper Perham #1				yoy	7	76
2.33	Gravel Bar Riffle				yoy	7	75
2.14	Old Yella Riffle				yoy	29	73
1.96	Big Spruce Run				yoy	30	66
1.65	Battleship Boulder				yoy	30	61
1.5	Lower Perham #1				yoy	14	77
1.45	Above the Bend				yoy	5	73
Cottle Stream							
4.85	Triple Birch riffle				yoy	13	53
4.76	Angle Ash riffle				yoy	30	49
4.67	Cottle Brook #6				yoy	21	53
4.6	Yellow Birch riffle				yoy	13	59
4.39	RR Ledge Bottom				yoy	6	62
3.98	Cottle Brook #5				yoy	2	63
2008							
Sandy River							
103.94	Cobble Riffle	parr	1	142			
103.33	Above Bean property below Rte	parr	3	137	yoy	2	79
103.16	Bean Property #2	parr	1	117	yoy	5	78
100.89	Below ledges below Saddleback	parr	1	120	yoy	7	75
100.76	Below Saddleback stream	parr	3	136	yoy	6	76
100.57	1st site above Madrid Index				yoy	4	78
99.41	Rte 4 Madrid	parr	2	130			
98.95	Below Madrid Pool	parr	2	126			
98.86	Double Birch Riffle	parr	3	135			
74.27	Below Dickey Brook #2	parr	1	172	yoy	4	63
73.36	Top of Rock Garden				yoy	2	63
South Branch Sandy River							
1.11	Above Egg Planting Site	parr	4	132			
0.7	Site #5	parr	3	106			
0.48	Site #4	parr	2	113			

Orbeton Stream							
12.72	Scarred Birch	parr	7	111			
11.99	Hemlock Riffle	parr	6	123			
8.64	2007 ISI site	parr	2	133			
8.55	Above Perham Confluence	parr	2	121			
0.96	Echo Valley Road below Boulder	parr	1	113			
Perham Stream							
2.14	Old Yella Riffle	parr	7	112			
1.65	Battleship Boulder	parr	65	111			
1.28	Breaching Whale Boulder	parr	8	120			
1.12	Four Run Riffle	parr	3	129			
Cottle Stream							
5.15	Cottle Brook #6	parr	4	107	yoy	2	60
3.98	Cottle Brook #5	parr	11	100			
2.99	Rte 4 riffle	parr	2	137			
Saddleback Stream							
0.84	Above Camps				yoy	8	72
0.64	Saddleback Camps	parr	1	146	yoy	10	72
0.2	Bellona Riffle				yoy	31	61
0.06	Ledge Falls Riffle	parr	1	167	yoy	45	60

Table 7.3. Three age classes of Atlantic salmon released over six years into the Sandy River Drainage. Egg numbers are those planted the previous year.

Year	Fry	Eggs	Adults
2003	39,000	0	0
2004	55,000	12,000	0
2005	30,000	18,000	0
2006	6,500	41,800	0
2007	15,400	18,000	0
2008	0	245,500	106
Total	145,900	335,300	106

APPENDIX A - History of Management Plan

<u>Diadromous Fish Restoration on the Kennebec River</u>

(The information contained in the following sections is intended as an overview of the history of diadromous fish restoration in the Kennebec River watershed.)

1.1 History of the Management Plan

As documented in the *State of Maine Statewide River Fisheries Management Plan* (June 1982), the State's goal related to anadromous fish resources is:

> "To restore, maintain, and enhance anadromous fish resources for the benefit of the people of Maine."

With the following objectives:

1. Determine the status of anadromous fish stocks and their potential for expansion;

2. Identify, maintain, and enhance anadromous fish habitat essential to the viability of the resource; and

3. Provide, maintain, and enhance access of anadromous fish to and from suitable spawning areas

With respect to the Kennebec River, the State's goal is to:

> "Restore striped bass, rainbow smelt, Atlantic sturgeon, shortnose sturgeon, American shad and alewives to their historic range in the mainstem of the Kennebec River."

In 1986, the Maine Department of Marine Resources (MDMR) developed *"The Strategic and Operational Plan for the Restoration of Shad and Alewives to the Kennebec River Above Augusta."* The goal of this plan was:

> "To restore the alewife and shad resources to their historical range in the Kennebec River System."

To meet this goal, the following objectives were developed:

1. To achieve an annual production of six million alewives above Augusta; and

2. To achieve an annual production of 725,000 American shad above Augusta

Coincidentally with the creation of this plan, the Kennebec Hydro Developers Group (KHDG) was created and a new *Operational Plan for the Restoration of Shad and*

Alewives to the Kennebec River was implemented in 1986. This plan became the first "Agreement" between the KHDG and MDMR. While its goals and objectives were the same as those of 1985, it allowed dam owners upstream of Edwards dam to delay the installation of fish passage in exchange for funding a trap, truck, and release program to move adult alewives and shad into upstream habitat.

In 1993, the Natural Resources Policy Division of the Maine State Planning Office drafted the *Kennebec River Resource Management Plan: Balancing Hydropower Generation and Other Uses.* Its goal for anadromous fish restoration in the Kennebec River remained the same as that established in 1982:

> "To restore striped bass, rainbow smelt, Atlantic sturgeon, shortnose sturgeon, American shad, and alewives to their historical range in the mainstem of the Kennebec River."

The objectives for striped bass, rainbow smelt, Atlantic sturgeon, and shortnose sturgeon were to restore or enhance populations in the segment of the Kennebec River from Edwards dam in Augusta to the Milstar dam in Waterville. At the time of the 1993 Agreement, there was an ongoing MDMR enhancement program for striped bass that consisted of fall fingerling releases. Since mature striped bass, rainbow smelt, and Atlantic and shortnose sturgeon will not utilize fish passage facilities, the strategy for the restoration of these species was to remove the Edwards dam. Its removal would also enhance the ongoing shad and alewife restoration program by reducing the cumulative impacts of dams on out-migrating juvenile alosines.

With the end of the KHDG Agreement and the removal of the Edwards dam, a second agreement, *The Agreement Between Members of the Kennebec Hydro Developers Group (KHDG), The Kennebec Coalition, The National Marine Fisheries Service, The State of Maine, and The US Fish and Wildlife Service,* was implemented on May 26, 1998. Under this Agreement, the MDMR continues to be responsible for implementing a trap, truck, and release program for anadromous alewives and American shad. MDMR is also responsible for ensuring that the goals and objectives identified for the Kennebec River in the 1982 plan are met through monitoring and assessment of other anadromous fish species. MDMR, the KHDG, and the US Fish and Wildlife Service provide funds for the continued implementation of the state fishery agencies' fishery management plan.

In 1984, the Maine Atlantic Sea-Run Salmon Commission (MASRSC) adopted the *Management of Atlantic Salmon in the State of Maine: a Strategic Plan*. In the plan, the MASRSC partitioned existing and historical salmon rivers into four categories (A, B, C, and D). The Kennebec River was one of five historical Atlantic salmon rivers assigned to category "C" primarily because salmon habitat was inaccessible due to impassable dams and lack of resources to initiate restoration.

In 1995, the MASRSC further delineated its proposed activities within the Kennebec River watershed in its *Maine Atlantic Salmon Restoration and Management Plan, 1995-2000.* The status of the Kennebec River Atlantic salmon resource was denoted as "unknown," but recognized that it included hatchery and wild origin strays with limited natural production. Restoration was deemed passive, with limited activities as resources allowed. The 1995-2000 goal for the Kennebec was to maintain current numbers of Atlantic salmon and increase those numbers in the future.

In 1997, the Maine Atlantic Salmon Authority (MASA, formerly the MASRSC) adopted the *Maine Atlantic Salmon Management Plan with Recommendations Pertaining to Staffing and Budget Matters.* In this document, the MASA identified a ten-year restoration goal to be undertaken in two phases. Under Phase I (1997-2001), the MASA would focus upon improving Atlantic salmon habitat and fish passage in the Kennebec River and tributaries below the Edwards dam site. The MASA supported ongoing efforts for removal of the Edwards dam. Phase II (2002-2006) objectives are to focus on developing a multi-agency fisheries management plan for the river above Lockwood, as well as initiating an Atlantic salmon stocking program.

1.2 Implementation of the Management Plan (1986-2001)

The strategy developed to meet the objectives of alosine restoration was planned in two phases. Phase I (January 1, 1986 through December 31, 2001) involved restoration by means of trap and truck of alewives and shad for release into spawning and nursery habitat. Phase II (January 1, 2002 through December 31, 2010), which is currently ongoing, involves providing upstream and down stream fish passage at Phase I release sites, as well as trap and truck operations to Phase II lakes. As originally planned, the Edwards dam (whose owner chose not to participate in the KHDG/State Agreement) was to be the primary site for capturing returning adults for the restoration program.

However, for several reasons, fish for the restoration were not obtained at Edwards until 1993. No capture facilities were available during 1987 and 1988; in 1989, an experimental fish pump was installed by the owner, but proved to be ineffective in capturing sufficient numbers for release in upriver spawning habitat. As a result, from 1987 through 1992, all the alewife broodstock stocked in Phase I lakes (see Table 1 for a list of these lakes) came primarily from the Androscoggin River.

A shift in the source of alewife broodstock occurred in 1993, due to an increased number of returns in the Kennebec below Edwards and the simultaneous decline in the run of the Androscoggin donor stock. In 1993, all adult alewives transferred to upstream habitat were Kennebec River returns and were predominantly trapped by netting. The broodstock source was split between the two rivers in 1994, but the bulk of the fish (93%) were Kennebec River returns, with most collected by the fish pump. Since 1995, MDMR has obtained alewife broodstock exclusively from the Kennebec River. Between 1996 and 1999, the majority of alewives transported were collected using the fish pump at the Edwards dam. In 2000 and 2001, all of the fish transported were again collected with the fish pump; however, following the removal of Edwards dam, the operation was moved upstream to Fort Halifax in Winslow.

Due to the increased number of adult alewife returns to the Kennebec River since 1994, MDMR typically not only meets Phase I stocking goals, but also has additional alewives available for other restoration sites in Maine. In 1998, alewives from the Kennebec were released into four additional ponds within its drainage and 14 ponds in eight other drainages. In 1999, due to a smaller run, this stocking practice was limited to three ponds in the Androscoggin River. In 2003, a record number of alewives were captured at Fort Halifax and released into 44 ponds throughout Maine, including all Phase I ponds that MDMR was permitted and chose to stock.

The Edwards dam issue was settled in 1998. The State of Maine took possession of the dam on January 1, 1999 as part of an agreement reached with the dam's previous owner, Edwards Manufacturing Company. The relicensing process of Edwards dam included several landmarks that contributed to the company's decision to turn the dam over to the state. In the fall of 1997, the Federal Energy Regulatory Commission (FERC) released a basin-wide Environmental Impact Statement, which recommended

removal of the Edwards dam. The FERC voted on this removal recommendation and ordered it in December 1997. In addition, Edwards' power contract with FPL Energy expired December 31, 1998. Rather than participate in a protracted legal battle, Edwards Manufacturing chose to negotiate with and turn the dam over to the State of Maine, allowing its ultimate removal by the state.
Physical removal of the dam began in early June 1999 and was completed by the end of October 1999. The breaching on July 1 and resultant fish passage, coupled with the dewatering of the impoundment previously created by the dam, allows restoration of the Kennebec and Sebasticook Rivers above Augusta. An important component of this restoration is the access to spawning and nursery areas for all anadromous fish species, including striped bass, rainbow smelt, shortnose sturgeon, and Atlantic sturgeon, none of which utilize conventional fish passage facilities. Since dam removal was not completed in time for the 1999 spring spawning runs of alewife and American shad, trap and truck operations continued at Edwards to ensure that those fish trapped below were able to spawn upstream.

On June 25, 1999, MDMR, in cooperation with the Maine Department of Inland Fisheries & Wildlife (IFW), installed a barrier on Sevenmile Brook to exclude undesirable, non-indigenous species. European carp, previously excluded by the Edwards dam, have been shown to be detrimental to pond ecosystems. At this time, not enough is known about the potential impacts of this species to risk NOT having a strategic barrier on the Sevenmile drainage. The barrier was installed May 3, 2003 and IFW was responsible for its cleaning and maintenance.

Under the Agreement with the Edwards dam removal, an interim trapping facility was constructed at the Fort Halifax dam on the Sebasticook River to collect returning adult alewives and American shad in the spring of 2000. This interim facility is slated to be used for the trapping and trucking of adults for release upstream through 2004.

Under Phase I of the restoration plan, only those lakes approved by IFW were to be stocked with six alewives per surface acre. Of the 11 impoundments listed under Phase I, only eight were stocked at the beginning of the program in 1987; Wesserunsett Lake was stocked beginning in 1996. Restoration at the remaining two Phase I impoundments, Threemile Pond and Three-cornered Pond, both in the Sevenmile Brook drainage, was delayed due to their marginal to poor water quality. In 2001, alewives were released into Threemile at a reduced rate of two alewives acre^{-1}; however, this was increased in 2002 to six acre^{-1}. Restoration at the ten remaining impoundments was contingent upon the outcome of a cooperative research project sponsored by MDMR, the Maine Department of Environmental Protection (DEP), and IFW to assess the interactions of alewives with resident smelt and salmonids. In June 1997, IFW confirmed that the Lake George Study indicated no negative impacts of alewife reintroduction on resident fish populations and outlined a schedule for stocking alewives into Phase II and Phase III habitat.

The initial restoration of alewives to Webber Pond had been postponed for several years to allow DEP time to establish a better long-term water quality database on this pond. In fact, MDMR deferred stocking alewives into the whole Sevenmile Brook drainage (Webber, Threemile, and Three-cornered Ponds) for a number of years due to the ongoing work in water quality improvement by DEP, local residents, lake associations, and the China Region Lake Alliance. In early 1995, MDMR, DEP, and IFW agreed that alewife restoration at six alewives acre^{-1} would have no negative impact on water quality and may, in fact, have a positive long-term impact through phosphorus export from the lakes. However, a conservative plan was agreed upon which called for initially stocking only Webber Pond. Webber was stocked in 1997 with two alewives per acre, followed by four alewives per acre in 1998, and starting in 1999, six per acre annually. As previously mentioned, MDMR implemented a conservative stocking plan at Threemile Pond in 2001 when alewives were released at a density of two alewives acre^{-1}.

In 2003, MDMR continued to transfer American shad from out-of-basin to the Waldoboro Shad Hatchery for use as captive broodstock in the tank-spawning program. However, beginning in 2001, MDMR collected broodstock from the Merrimack River rather than the Connecticut River because of its increased run size over the past few years and its closer proximity to Maine[6].

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[6] Shad restoration efforts in other rivers, such as the Susquehanna, have shown fry releases to be more successful than fingerling or adult releases. Therefore, no broodstock American shad have been transferred from out-of-basin (the Connecticut River was the primary source in past years) directly to the Kennebec River since 1997. Rather, MDMR has concentrated on providing broodstock for the hatchery's tank spawning effort.

In both 2000 and 2001, MDMR transferred broodstock from the Kennebec River to the shad hatchery. In 2002, a total of 50 shad were captured near the confluence of the Kennebec and Sebasticook Rivers, although only four females were transported to the hatchery (at the time of the shad capture, the hatchery was already near capacity with shad).

APPENDIX B - Proposed 2007 Trap & Truck Budget

Job 1. Trap and Sort Alewives

Transfer of broodstock alewives via Transvac pump at the Ft. Halifax facility will begin in May and conclude in June. About 90% of the alewife habitat that has been stocked in past years is in the Sebasticook drainage, which means that the majority of returning adult alewives will home to the Sebasticook River. Alewives returning to the Sebasticook River will be collected with the Transvac pump and then released into the Ft. Halifax headpond to continue upstream. Therefore, trucking operations will be greatly reduced from the Ft. Halifax facility with nearly all Phase I habitat in the Sebasticook River drainage accessible to the alewives with the new fish passages installed.

Job 2. Trap/Sort and Truck Alewives/American shad

Transfer of broodstock alewives via tank truck will begin in May and conclude in July. Alewives and American shad returning to the mainstem Kennebec will be captured at the fishlift facility installed by FPL Energy/Constellation Energy at the Lockwood hydroelectric facility. Alewives returning to Lockwood will be used to stock Wesserunsett Lake in Skowhegan as well as Douglas Pond on the Sebasticook drainage. Excess fish from the Lockwood facility will also be used to stock out of basin as time permits. The fishlift will deposit captured fish in a holding tank where undesirable species will be removed and returned to the river below the dam. Alewives will be sorted into receiving tanks with discharge pipes to be loaded into stocking trucks. American shad captured at the Lockwood fishlift will be loaded into a stocking truck and trucked to the Hydro-Kennebec headpond to saturate available habitat above that facility.

.**Job 2. Trap and Truck of American Shad**

Transfer of broodstock American shad via tank truck will begin in May and conclude in July. MDMR expects to transfer about 400-600 shad broodstock to the shad hatchery from the Merrimack River and or Connecticut Rivers. These fish will spawn naturally in tanks at the hatchery. For a complete description of shad hatchery operations see attached report.

Job 3. Transportation of American Shad Larvae

MDMR will load, transport, and release shad larvae produced at the hatchery. As the larvae reach 7 to 21 days old, they will be loaded into a transportation tank, trucked to the appropriate habitat, and released. This operation begins in mid-June and may continue through mid-August.

Job 4. Assessment of Young-of-Year American Shad and Alewives

MDMR will continue to sample young-of-year American shad in the segments of the Sebasticook and Kennebec Rivers that were stocked with shad fry, fall fingerlings, and adult broodstock. Sampling will occur between July and early November and may include seining, fyke netting, trawling, electrofishing, or sampling downstream migrants at hydroelectric sites. Representative numbers of juvenile shad will be retained for otolith extraction and checked for tetracycline marks applied at the hatchery.

Job 5. Assessment of Downstream Passage of American Shad and Alewives

MDMR will survey the outlet streams of lakes or ponds stocked with broodstock alewives to determine the feasibility of downstream migration of the postspawner adult and young-of-year alewives. Potential obstacles to passage will be recorded and revisited as the emigration of alewives is observed in the river system. Much of the stream survey work will take place in late June through August, with the follow up visits occurring as needed throughout the fall.

MDMR will visit hydroelectric dams, as well as non-hydro dams, located below shad and alewife stocking sites and record observations regarding the availability, quality, and effectiveness of downstream passage at these sites. The proper authorities will be notified if problems are observed. Dam surveys may begin as early as June and will take place through November and the termination of alosine emigration.

Job 6. Studies of the Fish Assemblage of the Kennebec River

MDMR will continue to collect data on the fish community at several locations in the Kennebec River between Merrymeeting Bay and Winslow. In addition, habitat data including DO, substrate type, water temperature and depth, flow, and measurements of bank stability and vegetation will be collected. This effort will continue in 2007.

Sampling methods will include fyke netting, electrofishing, minnow trapping, trawling, angling, and beach seining. Beach seines will be used as the primary means of capturing YOY fish. However, other means may need to be employed to capture adults. Samples will be collected biweekly from all sites and otoliths will be extracted from samples of American shad captured to determine the presence of an OTC mark.

2009 Budget Prediction

	Q1	Q2	Q3	Q4	TOTAL
Personal Services	$ 40,601.11	$ 62,513.87	$ 56,747.76	$ 46,368.76	$ 206,231.50
Operations/Maintenance	$ 5,773.51	$ 20,574.73	$ 13,178.81	$ 5,773.51	$ 45,300.56
Materials/Supplies	$ 91.18	$ 376.95	$ 234.07	$ 91.18	$ 793.38
TOTALS	$ 46,465.80	$ 83,465.56	$ 70,160.64	$ 52,233.45	**$ 252,325.44**

APPENDIX C—

\Proposed 2009 Kennebec River Atlantic Salmon Restoration

Work Plan and Budget

Proposed 2009 Kennebec River Atlantic Salmon Restoration Work Plan and Budget

Job 1. Perform Habitat Surveys on Tributaries of the Kennebec River.
A standard habitat survey will be conducted on selected tributaries of the Kennebec River. DMR staff from the Hallowell office will record quantitative measurements (length, width, depth, etc.), substrate composition, suitability for juvenile rearing, spawning, and holding habitat for salmon and provide Global Positioning System (GPS) points for habitat breaks. Work will continue within the Sandy River drainage, and the Sebasticook River.

Job 2. Produce Geographic Information System Coverages.
Using the habitat information collected above, DMR staff will produce Geographic Information System (GIS) coverages to display the location and estimate the amount of salmon habitat types available in the surveyed streams. Coverages produced from the 2001- 2008 habitat surveys will also give us the ability to display redd locations and areas of critical importance to salmon in the lower mainstem and tributaries.

Job 3. Assess Current Atlantic Salmon Populations in the Kennebec River and Tributaries.
DMR staff will continue to electrofish various waters including Togus stream and Bond Brook to 1) add to the historical database for Togus Stream and Bond Brook and document successful spawning and 2) assess other tributaries identified as having salmon habitat for presence/absence of salmon or to establish baseline fish species composition information.

In a further effort to assess adult returns to the lower Kennebec River and its tributaries, complete redd counts will be conducted on all spawning habitat identified by the habitat surveys. This will entail surveying for evidence of spawning salmon in the mainstem Kennebec from Waterville-Winslow to Augusta and all lower mainstem tributaries to their first upstream obstruction.

In addition, spawning surveys will be conducted on portions of the Sandy River in an effort to document successful spawning of translocated adult salmon.

Job 4. Continue Trap and Transport Operations at The Lockwood Project Fishlift
DMR staff in 2009 will continue to document adult returns and promote wild adult Atlantic salmon spawning in the Sandy River by assisting FPLE with trapping and translocation of all salmon captured at the Lockwood Facility Fishlift in Waterville.

Job 5. Instream Incubation
DMR staff will continue testing and expand instream egg incubation in the Sandy River drainage. Incubating Atlantic salmon eggs remotely in the Sandy River will provide DMR with the following information and benefits: 1) can eggs be used as a large scale reintroduction tool 2) if egg can be successfully used, is it a viable tool for volunteers 3) cost effectiveness for establishing a volunteer group instream incubation program.

Job 6. Annual Report and Recommendations
DMR staff will produce an annual report with recommendations for future salmon efforts in the Kennebec River and its tributaries. These recommendations will be based on available habitat, current population's status, and estimated salmon production potential in the waters currently accessible to salmon.

Job 7. Public Outreach
DMR staff will participate in meetings, forums, round-tables, etc. as necessary to appraise public and private groups of activities within the Kennebec River drainage. This will include interpretation, explanation, and promotion of DMR programs, policies, and concerns to the public, private organizations, stakeholders, and the media in the Kennebec River watershed.

	Q1	Q2	Q3	Q4	Totals
Personal Services	$3,634.11	$7,268.22	$10,902.44	$10,902.44	$32,707.21
Materials/Supplies	$756.25	$756.25	$756.26	$756.25	$3,025.01
Operations/Maintenance	$125.00	$2,248.46	$2,248.46	$1,540.64	$6,162.56
Capital	$ -	$ -	$ -	$ -	$0.00
Totals:	$4,515.36	$10,272.93	$13,907.16	$13,199.33	$41,894.78

2007/2008 Instream Incubation Report

(Paul M Christman, Dan McCaw and Jason Overlock)

Background/Introduction

The Department of Marine Resource (DMR), formally Atlantic Salmon Commission, has been focused on developing instream incubation as a feasible technique for Atlantic salmon restoration in the Kennebec River since 2002. Instream incubation could provide a low cost restoration option given the lack of resources available for the Kennebec River while introducing high quality juvenile. Two of the issues addressed to date are reducing transport mortality when moving green or eyed eggs to the Sandy River, and overcoming the logistical difficulties of planting eggs.

In 2003 the United States Department of Agriculture (USDA) began receiving Penobscot River sea-run origin eggs to rear for control purposes within the aquaculture research program in Franklin, Maine. This work necessitated rearing Penobscot origin salmon to produce eggs. They have requested eggs through the Maine Technical Advisory Committee (TAC) annually and have continued to receive them. The fall of 2007 marked the first year class of salmon to mature in this program. While these adults were reared for egg production, USDA did not require all the eggs. The program only requires several hundred eggs from each female. For the 2007 spawning year they were holding approximately 180 adults.

We proposed for the 2007-2008 project that the eggs surplus to the USDA along with surplus egg from Green Lake National Fish Hatchery (GLNFH) be used in the Kennebec River restoration program to test egg planting capability.
We also propose that 9000 green eggs be planted in the Sandy River to continue to develop green eggs as a viable supplementation tool.

Methods

USDA Eggs

On October 24, 2007 eight F1females and males of Penobscot origin stock were stripped of there gametes for the purposes of our study. Each females eggs and each males milt was carefully stripped into separate .95L zip lock bags and filled with 0_2. They were placed on towels and on ice in coolers for transportation.

The eggs were taken to three locations in the Sandy River drainage. The three treatment sites were Orbeton Stream, Perham Stream and Cottle Stream. Each site was chosen due to access and the quality of spawning and juvenile rearing habitat. Each site was marked with paint on trees and distances were measured from the marks. Each site was also sampled for permeability in an attempt to correlate with emergence if possible. A description of the permeability sampling protocols can be seen in the Atlantic Salmon Commission document by Gregory Mackey, Field Methods for Gravel Permeability Estimation: 2005 Protocols. Each of the three treatment sites was sampled three times at five points in the proximity of where the artificial redds were going to be created.

At each site a portion of each female's eggs were placed in a small plastic container. Each container of eggs was then fertilized with a small portion of each of the males milt to achieve one to one mating. After approximately several minutes all the eggs were combined in a bowl and rinsed with stream water repeatedly. During and after rinsing, egg were measured out into 262-684 egg aliquots and planted in pockets in the gravel with the hydraulic egg planter. A detailed description of the hydraulic egg planter and planting technique can be seen in the 2006/2007 instream incubation report. A count of eggs was derived from photos taken at the time of planting. The total number of eggs planted at each location was Orbeton Stream 2421, Perham Stream 2528 and Cottle Stream 4427 eggs. The number of aliquots at each site was 8 at Orbeton and Perham and 11 at Cottle stream.

The remainder of allocated eggs at the USDA facility were fertilized on station and incubated until they reached the eyed stage. Unfortunately due to a malfunction in the water cooling system, development was accelerated with warm water and eggs surpassed the eyed stage and began hatching prematurely. On December 18, 2007 we divided 16,595 eggs into several 3.79L jugs with and transported them to each of the treatment sites. Utilizing the same planting technique, we planted 2517 eggs in Orbeton Stream, 2448 eggs in Perham Stream and 2630 eggs in Cottle Stream adjacent to each of the green egg treatments. The aliquot divisions were 5 in Orbeton and Perham streams and 6 in Cottle Steam. In addition, approximately 9,000 eggs were planted in Warm Brook just above the Reeds Mills Rd. On December 19, 2007 the remainder of the eggs, approximately 20,000, were loaded into several 3.79L jugs and transported to the Sandy River and planted. The eggs were planted just below the junction of Dickey Brook and the Sandy River in Avon.

USFWS Eggs

On November 28, 2007 we received approximately 100,000 eggs from Green Lake National Fish Hatchery (GLNFH). We stripped 30 male and females into .95L zip lock bags and filled them with 0_2 in the same manner as the USDA eggs. We transported them on towels with ice in coolers to Orbeton Stream. The Orbeton Stream site chosen was just above the junction of Perham Stream in Madrid Township. Upon arrival each female's eggs were fertilized with a males milt in the bag. Within several minutes of fertilization each bag of eggs was planted in the same manner as the USDA eggs in multiple aliquots or pockets.

Similarly on November 29, 2007 we received an additional 100,000 unfertilized eggs from GLNFH. All handling was in the same manner as was done on the 28th. The planting sites chosen were in Avon and Phillips on the mainstem Sandy River. A separate redd was created with five aliquots of between 200-500 eggs. The emergence from this redd was to be used to generate an estimated emergence for the entire planting area. In addition, samples of milt from three males were taken back to the lab in Hallowell Maine to check for motility.

To assess the egg planting, the three sites that received the USDA eggs and the single site in Phillips were fry trapped to obtain an emergence rate. For a full description of the fry traps and techniques see the 2006/2007 instream incubation report.

Results

All fry traps were installed and operational on May 19, 2008. Unfortunately the Orbeton Stream treatment site suffered the loss of one of the marked trees used to coordinate the location of the artificial redd along with a shift in the channel. We estimated where the redds were and installed the fry traps. Other than a few debris jams in the cones leading into the capture chambers all trapping progressed normally.

Semi-daily tending's were conducted until June 24, 2008 and all fry were enumerated. Orbeton Stream did not produce any fry (Table 1.). Perham Stream produced three fry in the green egg treatment and 19 fry in the eyed egg treatment. Cottle Steam produced 1 fry in the green egg treatment and 58 in the eyed egg treatment. The single trap on the mainstem in Phillips did not produce any fry.

The mean permeability's for each of the treatment sites ranged from 1272.8 to 2476 $K_{10.}$

Table 1. Fry emergence for seven artificial redds in the Sandy River drainage. CS=Cottlle Stream, PS-=Perham Stream, OS-=Orbeton Stream. e=eyed eggs and g=green eggs.

	Location						
Date	OS-g	OS-e	PS-g	PS-e	CS-g	CS-e	Sandy-e
5/19	0	0	0	1	0	0	0
5/21	0	0	0	0	0	0	0
5/23	0	0	2	1	0	0	0
5/27	0	0	0	1	0	0	0
5/30	0	0	0	0	0	0	0
6/2	0	0	0	0	0	0	0
6/5	0	0	0	0	0	0	0
6/7	0	0	0	0	0	0	0
6/9	0	0	0	0	0	2	0
6/10	0	0	0	4	0	24	0
6/11	n/a	n/a	0	4	0	9	n/a
6/12	0	0	0	0	0	7	0
6/13	0	0	1	2	0	4	0
6/14	0	0	0	4	0	1	0
6/16	0	0	0	2	0	0	0
6/18	n/a	n/a	0	0	1	11	n/a
6/20	n/a	n/a	0	0	0	0	n/a
6/23	0	0	0	0	0	0	0
6/24	n/a	n/a	0	0	0	0	n/a
Total	0	0	3	19	1	58	0
Eggs Planted	4427	2630	2528	2448	2421	2517	n/a
% Emergence	0	0	0.12	0.78	0.04	2.30	

Table 2. Gravel permeability at three instream incubation sites in the Sandy River drainage.

Treatment Site	n	Mean K_{10}	sd
Orbeton Stream	5	2476	307.948
Cottle Stream	5	1272.8	970.054
Perham Stream	5	1882.333	964.229

Discussion

Over the past several years we have had difficulty producing juveniles from green egg. Our belief has been that handling shock was the main reason for failure. Green eggs are notorious for there sensitivity to movement after the first half hour after fertilization. It wasn't until we moved egg either unfertilized or in gallon jugs that eggs developed.

In the 2007-2008 project, we used the same protocols for handling that we followed the year we had success with green eggs. We moved all the eggs unfertilized and used photos for counts. This should have minimized or eliminated all handling associated mortality.

The lack of emergence in this year's project indicates there could a source of mortality that we have been unaware of or underestimating. Even though unlikely one possibility is the new hydraulic planter could be the source of mortality. Our operating procedures for the planter have been to shut the pump off and only use the pipe to deliver the egg into the gravel. The only force the egg experience is the water above the eggs when the valve is opened. We expect the freshly fertilized eggs just prior to water hardening to be vulnerable to shock however studies done regarding mechanical shock of green eggs within the first six ours indicates only about 10% mortality at drops of 17.5-38.5cm out of water (Krise, 2001). We would not expect our planter to exceed or even approach this severity. In addition, eyed eggs have developed in both years we have used the planter. The force would have to be sever enough destroy the green eggs and leave the eyed egg unharmed.

One additional problem could be the way in which the planter deposits the eggs. Given the number of non-developing eggs, due to relatively low eye up rates (70%) in the F2 eggs, it is conceivable that they are becoming overwhelmed with fungus. If the planter deposits the eggs in a single clump it could, by having too many eggs touching each other, allow fungus to spread. Our planting procedure of 200-500 eggs in a pocked is based on both sea-run salmon redds that have been excavated as well as eyed egg planting currently being conducted in Alaska. Both sources of eggs would be expected to have very few non-developing eggs. This could explain why eyed eggs produce fry and green eggs fail.

The eyed eggs, even though emerging in very low numbers, were considerably more successful than anticipated. Given that hatching was underway in December indicates they were far too advanced developmentally and would have been expected to suffer from developmental abnormalities. It is surprising that any alevin survived.

The most successful achievement of this year's project was the number of eggs planted. The GLNFH eggs were planted in approximately 10 hours. We averaged 5000 eggs every 15 minutes.

Literature Cited

Krise, William F. 2001. Sensitivity of atlantic salmon eggs to mechanical shock during the first six hours after fertilization. North Amer. J. Aqu. 63:34-37.

APPENDIX E—
Kennebec River Atlantic Salmon Interim Restoration Plan
2006-2011

Kennebec River Atlantic Salmon Interim Restoration Plan 2006-2011

Current Status of Atlantic Salmon Restoration Program

Background

In 1984, the Maine Atlantic Sea Run Salmon Commission (MASRSC) adopted *'Management of Atlantic Salmon in the State of Maine: a Strategic Plan'*. In the plan, the MASRSC partitioned existing and historical salmon rivers into four categories (A, B, C, and D). The Kennebec River was one of five historical Atlantic salmon rivers assigned to category "C" primarily because Atlantic salmon habitat was inaccessible due to impassable dams and lack of resources to initiate Atlantic salmon restoration.

In 1995, the MASRSC further delineated its proposed activities within the Kennebec River watershed in its *'Maine Atlantic Salmon Restoration and Management Plan, 1995 – 2000'*. The status of Kennebec River Atlantic salmon resource was denoted as "unknown" but recognized it included hatchery and wild origin strays with some limited natural production. Restoration was passive, with limited activities as resources allowed. The 1995 –2000 goal for the Kennebec was to maintain current numbers of Atlantic salmon and to increase those numbers in the future.

The Maine Atlantic Salmon Authority (MASA, formerly the MASRSC) adopted the *'Maine Atlantic Salmon Management Plan with Recommendations Pertaining to Staffing and Budget Matters'* in 1997. In this document, the MASA identified a ten-year restoration goal in two phases. Under Phase I (1997 – 2001), the MASA would focus upon improving Atlantic salmon habitat and fish passage in the Kennebec River and tributaries below the Edwards Dam. The MASA supported efforts that resulted in the removal Edwards Dam. Phase II (2002 – 2006) objectives are to focus on developing a multi-agency fisheries management plan for the river above the Lockwood Dam and initiating an Atlantic salmon stocking program.

Current Program Status

- The Sidney field office of the Maine Atlantic Salmon Commission (MASC) was established in 2000 to work on central/southern Maine salmon rivers, including the Kennebec River. This office currently has a staff of one fulltime biologist, one fulltime biology specialist and a 9-month conservation aide. The conservation aide is the only staff member with a salary paid from Kennebec River dedicated funds. This position is funded until 2010.
- To date the MASC has documented juvenile salmon habitat in several Kennebec River tributaries, including the Sandy and Sebasticook rivers and Bond Brook, Togus and Cobbosseecontee streams as well as the mainstem Kennebec River. MASC has begun small releases of juveniles in the Sandy River and worked with stakeholders to gain upstream and downstream passage at the Anson, Abenaki, and Sandy River projects.
- Two agreements govern the timing of upstream and downstream fish passage construction and operation in the Kennebec River drainage. The Lower Kennebec River Comprehensive Hydropower Settlement Accord (1998) covers upstream

and downstream passage at the Lockwood, Hydro-Kennebec, Shawmut, and Weston projects on the mainstem and at Ft. Halifax, Benton Falls, and Burnham on the Sebasticook River whereas the 2002 Offer of Settlement with Madison Paper, Inc. (MPI) provides for passage at their Anson and Abenaki projects.

- Plans are currently underway by Kennebec River stakeholders to remove the Sandy River Project hydro dam in 2006. The dam, owned and operated by Madison Electric Works, is the only dam on the mainstem Sandy River.
- MASC staff has also begun the planning process to move adult salmon upstream into the Sandy River as part of interim passage when the first capture facility at Lockwood becomes operational in the spring of 2006. .
- MASC has also begun exploring possible egg sources appropriate for restoration of Kennebec River salmon.

Current Atlantic Salmon Population Status

- The number of adults returning to the Kennebec River is unknown due to the lack of a fish trapping facility. Using anecdotal angler catches of Atlantic salmon in the Kennebec River (Table 1.) and returns to the Androscoggin River (Table 2.) MASC expects the number of salmon captured at the Lockwood Project will not exceed 25 adult fish in 2006.
- The origin of adult returns to the Kennebec River is also unknown. Tagged salmon caught by anglers in the Kennebec River and analysis of scale samples taken from Androscoggin River returns to the Brunswick trap suggest that the majority of adult salmon in the Kennebec River are strays from the Penobscot River smolt stocking program.
- Two tributaries (Togus Stream, Bond Brook) located below the old Edwards Dam site, have had documented adult returns and juvenile salmon. Monitoring over the past five years by MASC biologists seems to indicate that both populations are very small. Both tributaries are currently within the Gulf of Maine Distinct Population Segment (DPS) of Atlantic salmon listed as endangered under the federal Endangered Species Act (ESA).
- From 2003-2005 three small cohorts of salmon have been introduced into the Sandy River in an effort to gain insight into habitat quality (Table 3). All three cohorts have been monitored through population assessments. Very few adult returns are expected from these plantings.
- In addition, small numbers of juveniles are introduced throughout the watershed annually by the Fish Friends Program. No monitoring has been done on these smaller introductions.

Estimated Units of Atlantic Salmon Habitat

- Based on Foye et al. (1969) and recent surveys conducted by MASC personal there is over 132,000 metric units ($100m^2$) of juvenile Atlantic salmon habitat distributed through the Kennebec River watershed. Table 4 summarizes the amount and distribution in the watershed.

Estimate of Potential Adult Returns

- Table 4 summarizes the estimated juveniles and potential adult returns for the Kennebec River according to habitat figures. The assumptions made to derive figures are listed in the table.

Angling Potential

- Anglers caught Atlantic salmon in the Kennebec River before Edwards Dam removal (Table 1).
- Since the removal of Edwards Dam approximately 15 miles of riverine habitat is available for adults below the first dam. This section would likely be considered the primary Atlantic salmon angling water.
- Boat anglers could access the river at several boat launches between Waterville and Augusta. There is foot access for wading in the vicinity of Fort Halifax in Winslow and at various other access points requiring landowner permission.
- The Kennebec River is also readily accessible to a large human population in those counties either wholly or partially within 50 miles of Waterville and Augusta (Table 5). These counties make up over 72% of Maine's population.

Five-Year Restoration Goal

Purpose

The primary purpose for the restoration of the Kennebec River Atlantic salmon run is to fulfill MASC's mandate to restore Atlantic salmon for the benefit of the people of Maine. The restoration of the Kennebec River depends, in part, on fish passage at hydropower facilities, quantity and quality of juvenile and adult salmon habitat, and the availability of resources to the agency. Since the construction of Edwards Dam in 1837 salmon have not had access to juvenile habitat in headwater tributaries. However, fish passage has and will continue to improve dramatically. The removal of Edwards Dam, the pending removal of Madison Electric Dam and the construction of a fish lift and capture facility at the Lockwood Project in Waterville will allow access for returning adults to spawning and juvenile habitat. Habitat surveys from 2001 to 2005 and small releases of fry have confirmed the habitat in the Sandy River is capable and extensive enough to support an abundant juvenile Atlantic salmon population. In addition, the Kennebec River could yield a tremendous Atlantic salmon fishery. As mentioned above, the Kennebec River has approximately 15 miles of river between Waterville and Augusta that would be considered the primary angling water. Much of this section has angling potential for drift boat and wade fishing. Habitat surveys have identified numerous Atlantic salmon holding and resting pools and shallow water valuable for angling. Also, with 72% of Maine's population within 50 miles of this stretch of river, its access for anglers is unsurpassed in the state.

Restoration of the Kennebec offer opportunities to build on Maine's Atlantic salmon restoration program on the Penobscot River. The Kennebec River is similar to the Penobscot River in that it also has over 100,000 units of Atlantic salmon habitat. Smolts, parr, and fry are released annually in the Penobscot River to supplement wild reproduction, with assessment keyed on adult returns by cohort. On the Kennebec, the ASC sees a unique opportunity to experiment in a habitat rich system for the benefit of both rivers. For example, implementing new and creative management techniques and assessing alternate enhancement strategies, such as streamside and instream incubation, can be done without risking or complicating current management.

Geographical Range of Plan
The five-year Atlantic salmon restoration goal for the Kennebec River encompasses all historical Atlantic salmon habitat from the old Edwards Dam site in Augusta up to the Anson and Abenaki projects in Madison. In addition, initial habitat assessments will begin on the Carrabassett River.

Implementation of Plan
To aid in accomplishing the objective outline below a work plan had been developed (Appendix A). The intent is for the work plan to annually be updated to reflect new information and changes that may occur during the life span of the plan. The Interim Restoration plan is not intended to restrict efforts but to act as a guide allowing for adaptive management.

Objectives
Sevenmile Brook
- As a result of the Edwards Dam removal this small tributary is now accessible for Atlantic salmon. It has a small amount of Atlantic salmon habitat and will continue to be monitored through redd surveys, when possible, in the event salmon should re-colonize.

Messalonskee Stream
- Similar to Cobbosseecontee Stream, this tributary does not have passage at the several dams found within the lower reaches of the stream. The small amount of habitat presently available will be monitored through electrofishing and redd counts in the event salmon should attempt to re-colonize.

Sebasticook River
Passage
  - All Atlantic salmon will be passed upstream in the Sebasticook as passage facilities become operational. Efficiency/effectiveness of passage/trapping facilities will be evaluated upon completion. The MASC will need to coordinate with Department of Marine Resource and Inland Fisheries and Wildlife to sort at passage facilities in this watershed as they become operational.
- If resources become available juveniles could be release into this drainage.
- Monitoring juvenile production and adult spawning will begin when adults have passage

Mainstem Kennebec River Below Waterville
- Since the removal of the Edwards Dam this section of river is open to Atlantic salmon. Monitoring through electrofishing and redd counts when possible will take place.

- Behavior, migratory timing and routes as well as capture efficiency/effectiveness of passage/trapping facilities of returning adults, out-migrating kelts, and smolts will be evaluated.
- This sections will primarily be considered a corridor for migration.
-

<u>Mainstem Kennebec River Between Waterville and Madison</u>

- The quality and quantity of juvenile and adult holding habitat in this section is largely unknown. As upstream passage is obtained and resources become available habitat quantity and quality will be assessed. Habitat assessment need not be by survey – could involve satellite imagery or GIS modeling.
- With passage, this river section will primarily be a corridor for migration. However, in the event that juvenile habitat is documented, it may be considered for juvenile introductions.
- Downstream passage of both kelts and smolts should be evaluated for passage efficiency/effectiveness as well as to establish behavior, migratory timing and routes

Various tributaries Between Waterville and Skowhegan

- Several small tributaries identified as having salmon habitat enter the mainstem of the Kennebec River between Waterville and Skowhegan. Their potential for restoration as well as passage is unknown. Habitat data will be collected either by survey, satellite or GIS modeling.

Sandy River

Given the quantity and quality of documented juvenile and spawning habitat present, the Sandy River offers the best opportunity to initiate a restoration program in the Kennebec River drainage.

<u>Interim Upstream Passage to the Sandy River</u>

The MASC will work with owners of hyro-projects to capture adult Atlantic salmon at either Lockwood or other capture facilities to transport adults to the Sandy River. In order to promote river specific stock returning adults will be allowed to spawn naturally. However, if sufficient numbers of adults return, and/or a broodstock management plan can be developed that will reinforce and support river specific adaptations, adults could be removed to develop a river specific broodstock source for additional supplementation.

Initiate Sandy River Juvenile Introductions

It is unlikely that the small numbers of adult Atlantic salmon anticipated to return to the Kennebec River are sufficient to establish a population. It is important to supplement and boost the population, not only to have as diverse a genetic pool as possible, but also to have annual returns in large enough numbers so that adults can find one another and successfully spawn. As the population grows juvenile introductions will be reevaluated, adjusted and/or suspended.

- By 2008 provide at least 500,000 Atlantic salmon eggs/fry for distribution into the Sandy River basin. This target number will utilize about 25% of the documented habitat.
- By 2011 provide at least 1,000,000 Atlantic salmon eggs/fry for distribution into the Sandy River basin. This target number will utilize about 50% of the documented habitat in the Sandy River.

Broodstock

Currently there is no broodstock source for the Sandy River. Ultimately a reliable egg source will need to be established to ensure continuing restoration beyond this plan if needed. Several potential sources for supplementation have been identified.

Passage Upstream and Downstream

- Smolt passage will need to be evaluated for effectiveness, timing and insight into migratory behavior along the migratory routes in the non-obstructed portions of the Kennebec River including the Sandy River.
- Adults released in the Sandy River should be evaluated to determine trap and truck interim passage effectiveness, behavior and spawning effectiveness.

Tributary Passage Status

- The Sandy River has many large tributaries potentially capable of sustaining Atlantic salmon. In addition to assessing the quantity and quality of habitat in each tributary they should be surveyed for dams. As the need and opportunity arises passage should be obtained through installation of fishways, rock ramps or removals.

Habitat Surveys

- Quantitative habitat surveys have been conducted on the entire mainstem of the Sandy River and partially on one tributary. Given the size of many of its tributaries, they should be surveyed or modeled for quantity and quality of habitat as soon as time and resources allow.
- When fry/egg releases reach 200,000, including estimated wild reproduction, smolt trapping/tracking should be initiated to enhance our understanding of habitat quality, production potential and population size.

Carrabassett River

Even though the Carrabassett River will take a prominent roll in the next stage of Kennebec River restoration, activities will need to be initiated within the time frame of this plan. Currently passage agreements are in place that will give adults access to the Carrabassett River and the mainstem of the Kennebec River up to Solon. The Carrabassett historically supported its own population of salmon.

- Within the next five years habitat surveys will be conducted in the Carrabassett River drainage to determine access points, habitat quantity and quality, passage status and potential obstructions.
- Issues associated with restoration should be identified.

<u>Current Challenges and Issues</u>

- Inadequate resources to initiate, monitor and evaluate restoration program.
- Insufficient juvenile salmon available for stocking.
- Potential conflicts with other fishery management programs (e.g. brown trout, smallmouth bass).
- Unknown status of downstream passage
- Spread of invasive exotic fish species
- Inadequate upstream passage on the mainstem Kennebec River.
- Current passage triggers in Kennebec River are dependent on Shad returns. If shad triggers cannot be met another species would need to be used.
- Incidental take by anglers
- Inadequate Atlantic salmon habitat information
- Lack of volunteers/stakeholders.
- Barriers on tributaries

Five Year Program Requirements

Resources needed to achieve program requirements will primarily come from dedicated resources to the Kennebec and newly acquired resources. No current program will be sacrificed to initiate this plan.

1. One additional full time fisheries scientist. As recommended in the Maine Atlantic Salmon Commission's 10-year Strategic Plan the Sidney office needs a dedicated Biologist II to coordinate and evaluate management and research programs.
2. Current funding, to support the interim trap and tuck operation and restoration efforts including the Sidney office conservation aide, from the KHDG agreement will come to an end in 2010. New funds will need to be obtained to continue these efforts and secure this state position.
3. State and/or federal funding should be acquired at a level to match 50:50 any hydro-project funding dedicated to the Kennebec River. This funding will be used to support restoration and research needs.
4. The need for hatchery assistance is anticipated. Currently both Craig Brook National Fish Hatchery and Green Lake National Fish Hatchery are dedicated to

other restoration programs. If hatchery assistance is going to come from either one of these facilities it would need to expand to allocate space for the Kennebec River. It is possible if funding can be obtained to contract with a private hatchery to produce sufficient juveniles and/or hold adults to produce eggs or for direct release into the Sandy River.

5. Numerous grant opportunities exist that will need to be taken advantage of to implement research needed in the Kennebec River in addition to the resources outlined above.

Table 1 Angler catch in the Kennebec River reported in E.T. Baum 1997.
K=kill and R=released

Year	K	R	Year	K	R	Year	K	R
1936-1963	0	0	1974	4	0	1985	0	0
1964	0	0	1975	2	0	1986	0	0
1965	2	0	1976	0	0	1987	4	0
1966	0	0	1977	0	0	1988	2	0
1967	0	0	1978	0	0	1989	2	0
1968	0	0	1979	6	0	1990	46	60
1969	0	0	1980	4	0	1991	4	0
1970	0	0	1981	14	0	1992	0	0
1971	0	0	1982	24	0	1993	2	10
1972	0	0	1983	18	0	1994	0	1
1973	0	0	1984	1	0	1995	No Kill	0

Table 2. Adult Atlantic salmon trapped at Brunswick

Year	Adults
1995	16
1996	39
1997	1
1998	4
1999	5
2000	6
2001	6
2002	2
2003	5
2004	11
2005	10

Table 3. Two age classes of Atlantic salmon released over three years into the Sandy River Drainage.

Year	Fry	Eggs
2003	39,000	
2004	55,000	12,000
2005	30,000	18,000
Total	124,000	30,000

Table 4 Summary of juvenile habitat, potential smolt production and adult escapement. Habitat units (unit=100m^2) derived from Foye et al. 1969 and MASC surveys. Smolt estimates are for 2 and 3 smolts produced for each habitat unit. Target escapements are based on the amount of habitat, egg deposition of 240 eggs/unit, sex ratio of 50:50 and 7200 eggs for each female.

River Reach	Square Yards	Square Meters	Units	2.0 Smolts/unit	3.0 Smolts/Unit	Target Escapement
Kennebec River: Harris dam to The Forks	305,000	255,019	2,552	5,104	7,656	170
Kennebec River: The Forks to Wyman Lake	2,200,000	1,839,480	18,395	36,790	55,184	1,226
Dead River	2,963,700	2,478,031	24,780	49,561	74,341	1,652
Austin Stream	82,138	68,678	687	1,374	2,060	46
Kennebec River: Wyman Lake to Solon	1,173,000	980,777	9,808	19,616	29,423	654
Kennebec River: Solon to Madison	1,760,000	1,471,584	14,716	29,432	44,148	981
Carrabassett River	1,985,980	1,660,532	16,605	33,211	49,816	1,107
Kennebec River: Madison to Skowhegan	117,000	97,827	978	1,957	2,935	65
Sandy River*	2,186,589	1,828,267	18,283	36,566	54,849	1,219
Kennebec River: Skowhegan to Shawmut	291,532	243,758	2,438	4,875	7,313	163
Wesserunsett Stream	457,626	382,634	3,826	7,653	11,479	255
Carrabassett Stream	43,266	36,176	362	724	1,085	24
Martin Stream	64,202	53,681	537	1,074	1,610	36
Kennebec River: Shawmut to Waterville	na	na	na	na	na	na
Kennebec River: Waterville to Augusta**	1,604,811	1,341,826	13,418	26836	40,254	895
Sebasticook River (East Branch)	52,799	44,147	441	883	1,324	29
Sebasticook River to Old Power Dam, in Burnham	263,999	220,737	2,207	4,415	6,622	147
Twenty-Five Mile Stream**	46,165	38,600	386	772	1,158	26
Pattee Pond	5,866	4,905	49	98	147	3
China Lake Outlet**	71,520	59,800	598	1,196	1,794	40
Messalonskee Stream***	24,278	20,331	203	406	609	14
Seven Mile Brook**	12,080	10,100	101	202	303	7
Bond Brook**	20,930	17,500	175	350	525	12
Kennebec River: Augusta to Merrymeeting Bay	na	na	na	na	na	na
Cobbosseecontee Stream***	20,451	17,100	171	342	513	11
Togus Stream**	45,448	38,000	380	760	1,140	25
Eastern River	2,932	2,932	29	59	88	2
Total	**15,801,312**	**13,212,421**	**132,126**	**264,251**	**396,377**	**8,808.38**

*Incomplete habitat data collected by MASC.

**Habitat data collected by MASC

***Habitat data collected by MASC between Kennebec mainstem and first barrier.

Table 5. Source U.S. Census Bureau: State and County QuickFacts. Data derived from Population Estimates 2004.

County	Population
Androscoggin	107,022
Cumberland	273,505
Franklin	29,736
Kennebec	120,645
Knox	41,008
Lincoln	35,236
Oxford	56,614
Penobscot	148,196
Sagadahock	36,927
Somerset	51,584
Waldo	38,392
Total	**938,865**
Maine's population	**1,317,253**

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APPENDIX F—

2007 Kennebec River Radio Telemetry Feasibility Study

2007 Kennebec River Radio Telemetry Feasibility Study

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March 24th, 2008

2007 Kennebec River Radio Telemetry Feasibility Study

Introduction:

Translocation is the intentional release of animals into the wild in an attempt to establish, re-establish or augment a population. Translocation is a success if it results in a self-sustaining population, and increased habitat quality was associated with greater success (Griffith et al. 1989). That means that the chances of re-establishing a self-sustaining population in the historical range of the species are greater when the translocated adults are placed into the highest quality habitat available. Translocation of Atlantic salmon to the currently inaccessible Sandy River to re-establish a population can only happen if the translocated adults stay and spawn in the Sandy River.

Adult Atlantic salmon (ATS) generally migrate up their natal river in three distinct phases: rapid movement upstream for either long or short distances, a long residence period with little movement, followed by a short migration just prior to spawning (Hawkins and Smith 1986; Heggberget et al. 1988). Power and McCleave (1980) radio tagged and tracked hatchery reared (raised and released from Green Lake National Fish Hatchery as one-year smolts) ATS returning as adults to the Penobscot River. These smolt-stocked fish displayed no consistent pattern of movement, and were found to make erratic movements both up and downstream interspersed with times of no movement. A similar study conducted in 1987 also on the Penobscot River by Dube (1988), concluded that for these unknown origin and smolt stocked adult ATS movements of individual salmon varied tremendously during the study period. Johnsen and Hvidssten (2002), working in the river Ingdalselva in Norway, found that 77% of wild adult ATS transported at the time of spawning from their natal river to another river, stayed and spawned.

The *Kennebec River Atlantic Salmon Interim Restoration Plan 2006-2011* outlines the transport of all captured adult ATS from the Lockwood fish lift on the Kennebec River in Waterville to the Sandy River, a large tributary to the upper Kennebec River. Habitat surveys conducted by the Maine Department of Marine Resources (MDMR) staff, formerly the Maine Atlantic Salmon Commission (MASC), estimate 20,000 units of juvenile rearing habitat and over 1,900 units of adult spawning habitat in close proximity to the release site, as well as a number of large adult holding pools. Fifteen salmon were trucked and released into the Sandy River from the Lockwood Project in 2006, but despite numerous redd count surveys on the mainstem Sandy River and several tributaries in the fall of 2006, no redds were found. MDMR staff was unable to determine if the translocated fish had stayed and spawned in the Sandy River.

A radio telemetry feasibility study was conducted on the Kennebec and Sandy Rivers in 2007/2008. This study was conducted to assess the efficacy of manually radio tracking adult Atlantic salmon translocated to the Sandy River from the Florida Power and Light (FPL) Lockwood Hydro Project (FERC No. 2574) on the Kennebec River in Waterville, Maine. This radio telemetry project was initiated to determine if manual radio tracking could be used to effectively track ATS in the Sandy River and Kennebec Rivers, and therefore evaluate the management decision of translocating all adult ATS captured at the Lockwood Project fishlift to the Sandy River. This is a report describing the methods and results of this feasibility study through January 31st, 2008.

Methods:

Study Area-

The Kennebec River is the second largest river in the state of Maine and drains approximately 6,000 square miles, or 20% of the entire state. The Sandy River is a major tributary of the Kennebec River. The Sandy River originates at Sandy River Ponds in Sandy River Plantation in Franklin County. The Sandy River drains 593 square miles and flows in a southeasterly direction for 69 miles to its confluence with the Kennebec River in Starks. The area consistently tracked in the Sandy River was between Small's Falls in Township E, the uppermost barrier to migration (river km 106.75), to the Route 4 bridge in New Sharon (river km 29.36) (Figure 1.). River kilometers are measured from a river's head of tide or confluence to the uppermost origin of a river. The river km measure at head of tide or confluence would be River km 0.00. The release site for the translocated fish was in Madrid (river km 97.67, or 97.67 km from the Sandy River's confluence with the Kennebec River). New Sharon was the starting point for most tracking trips. We were able to utilize the extensive road network in the Sandy River basin and did most tracking by vehicle. Limited tracking by vehicle was also done on two large tributaries whose confluences are within two km of the release site. Orbeton Stream and the South Branch of the Sandy River meet the Sandy River at river km 95.58, and river km 97.76 respectively, and both tributaries contain large amounts of surveyed juvenile rearing, spawning, and adult holding habitat. Limited road access prevented tracking above river km 5.69 in Orberton Stream, and river km 5.68 in the South Branch of the Sandy River. The Kennebec River from Madison to Hallowell was also covered late in 2007 as some of the tagged fish were tracked moving to the lower portion of the Sandy River.

Equipment-

Advanced Telemetry Systems model 2100 receiver was used in conjunction with a three element folding Yagi antenna to track all tagged fish. Adult ATS captured at the Lockwood Project fishlift had radio tags (Advanced Telemetry Systems model #F184OB) inserted into their stomachs. Tracking was conducted by attaching the antenna to the canoe rack on the truck. The antenna cable was run into the cab of the vehicle and connected to the receiver. The receiver was powered by the vehicle's auxiliary power port (cigarette lighter). Additional fine-scale tracking was done on foot. The antenna was held by hand and an internal battery provided power for the receiver in these instances.

Study Fish-

All fish tagged in this study were captured at the FPL Lockwood Facility fishlift in Waterville, Maine. Captured fish were subject to the normal biological sampling regimen outlined in the former MASC Trap and Fish Handling Protocol (2005). The first five, multi sea-winter (MSW) fish received radio tags regardless of sex. The remaining four radio tags were implanted in only female MSW Atlantic salmon. No one sea-winter (1SW) fish were tagged.

Implanting Procedures-

Radio tags were implanted using a stiff plastic tube, following the protocol outlined by Dube (1988). Fish selected to receive radio tags were anesthetized using an 80-130mg/l solution of MS-222 and sodium bicarbonate (depending on water temperature) in 25 gallons of water contained in a 100-gallon tub. Tagged fish were held upright in the flow-through holding tank at the Lockwood Project until they recovered from the anesthetic. All tagged fish were then transported and released into the Sandy River according to the former MASC Trap and Fish Handling Protocol (2005).

Mobile Tracking-

Tagged fish were located by driving where roads paralleled the river and by access at strategic points where the roads were too far from the river to effectively receive the radio tag signal. Emphasis was placed on previous detection areas, and known holding pools. The road network from New Sharon to Madrid Township often covers both sides of the river. Multiple paths were taken in order to eliminate “dead” spots created by the rolling terrain. A GPS point was taken from the road at the point where a tag’s signal was the strongest. These points were then used to estimate the river km of the tagged fish. Visual confirmation of tagged fish was completed when time and visibility conditions allowed.

Radio tracking trips were mainly conducted by vehicle. However, there were instances where tracking on foot was used to verify fish holding areas, and to ensure the tagged fish were still alive and had not regurgitated the radio tag. Tracking events normally occurred when other fish were being transported to the Sandy River and for several days immediately after a tagged fish was released. After that, tracking was conducted a minimum of twice a week, most times in conjunction with other duties on the Sandy River. Electrofishing trips to the Sandy River also incorporated radio tracking, as did most all other trips to the Sandy River. Extensive redd count surveys conducted in the fall of 2007 always were done in tandem with radio tracking. Radio tracking effort was also increased after large rain events, or as work schedules allowed.

Other Data Collected-

Temperature data was collected on the Sandy River using an Onset Optic Stowaway temperature logger; set to record stream temperatures every hour. This data was collected to estimate the start and end of the spawning period for ATS. The large pools at river km 99.10 and 87.13 were snorkeled to verify tagged fish were still alive and to look for any untagged ATS adults.

Results:

The first tagged Atlantic salmon was released into the Sandy River on June 4th, 2007. The last study fish was captured, tagged, transported and released into the Sandy River on August 31st, 2007 (Table 1.) Four of the study fish were of hatchery origin, and five were of wild origin. All nine tagged and translocated fish released to the Sandy River were detected numerous times during the summer and fall months (Figure 2.) Eight of the nine tagged fish remained in the Sandy River throughout the summer months and into the spawning season. This data is summarized in Figure 3.

Eight of the tagged fish were detected in the Sandy River on November 9th. Six tagged fish were detected in the Sandy River on December 13th. The two missing fish, females Althea and Bellona, were detected making consistent downstream movements after October 29th and were last detected in the Sandy River in Farmington on November 26th, and November 19th respectively. No tagged fish was ever detected in the Sandy River downstream of New Sharon, despite several tracking events executed on this stretch of river. The tracking effort precipitously declined after December 13th, assuming that spawning had ended for the season.

Snorkeling was done to confirm fish to be alive, and to see if tags were regurgitated. Nyx was confirmed to be alive at river km 87.13 on September 26th. On October 4th, eight Atlantic salmon were observed in the pool at river km 99.10 by snorkeling. Three of the fish were tagged study fish. Three untagged MSW ATS, and two untagged 1SW ATS were also observed.

Table 1. Kennebec River Radio Telemetry Study Fish Data.

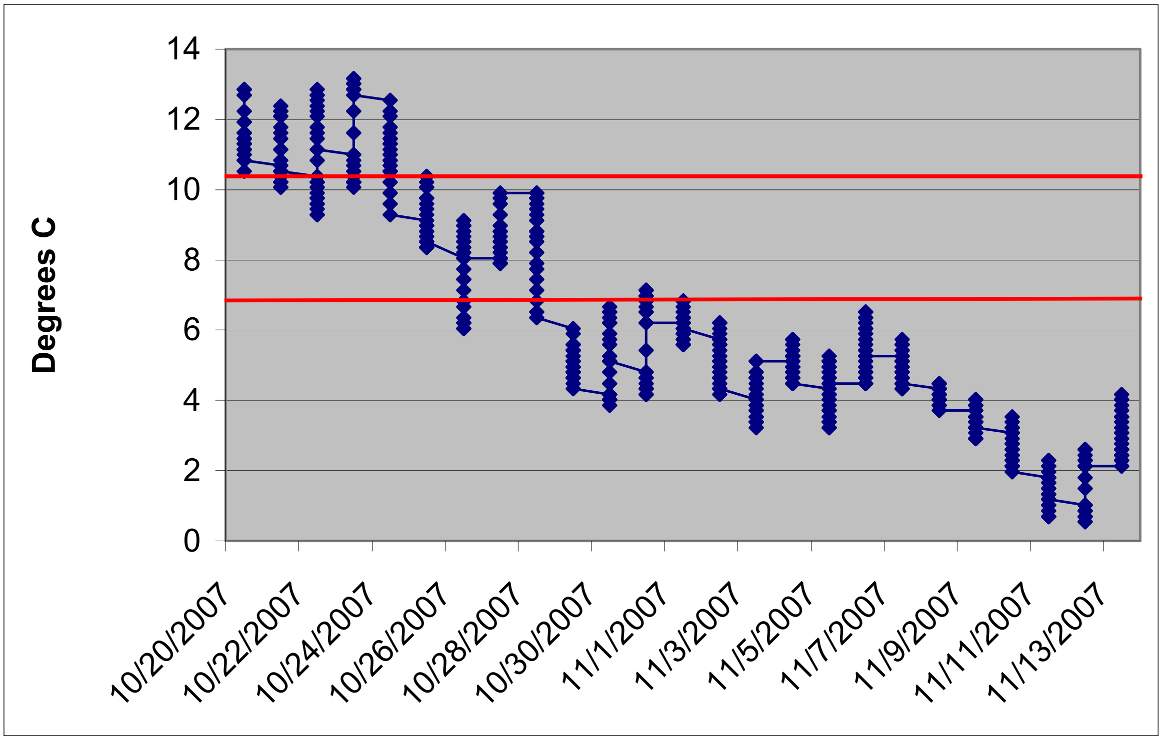
Capture Date	Fish Name	Sex (M, F, U)	Origin	Stray from another River? (Y,N,Unk)	Fork Length (cm)	Marks or Tags Observed
June 4th	Althea	F	W	N	77.0	none
June 17th	Bellona	F	W	Unk	71.5	none
June 21st	Cronus	M	H	Y	70.0	A Clip
June 27th	Evander	M	H	Y	74.5	A Clip, Elastomer, Left eye Green
June 28th	Helios	M	W	Unk	75.5	none
July 2nd	Iris	F	W	N	74.0	none
July 2nd	Kalypso	U	W	N	75.0	none
July 24th	Nyx	F	H	Y	70.0	none
August 31st	Themis	U	H	Y	69.5	none

The only study fish confirmed to leave the Sandy River before spawning, was tagged and released on June 27th, 2007. This fish had a green elastomer tag over its left eye, and an adipose fin clip. This fish was released as a smolt into the Penobscot River in 2005. This fish spent very little time in the Sandy River. It was detected on four occasions from July 2nd to July 10th, and displayed consistent downstream movement. The fish left the Sandy River sometime after July 10th, and was detected in the Kennebec River below Madison on July 15th. This fish was never detected in the Sandy River again and was last detected near the confluence of the Sandy and Kennebec rivers on October 16th.

25 separate redd count survey events were conducted on the Sandy River, Saddleback stream, and Orbeton stream from October 15th to November 19th. All surveyed spawning habitat was covered in the Sandy River from Small's Falls (river km 106.73) to Phillips (river km 85.38). All surveyed spawning habitat was covered in the lowest 1.15 km's of Orbeton Stream, and the lowest 0.49 km's in Saddleback Stream. All spawning habitat in these areas were covered several times in this period. Two redds were documented in Saddleback Stream and study fish Bellona was observed digging a redd in Saddleback stream on October 24th.

Additionally, temperature data was collected for the Sandy River through the fall months to determine spawning time, and is displayed in Figure 4. The red lines indicate the temperature range identified to correspond to the onset of ATS spawning. (Jordan and Beland, 1981)

Figure 4. Sandy River Daily Average Temperatures.



Discussion:

Tracking Observations:

The main objective of this study was to determine if manual radio tracking could be used to effectively track adult ATS in the Sandy River and Kennebec Rivers. However, it is difficult to quantify tracking efficiency for this study. Tracking events were done with differing levels of intensity, depending on the workload for the day. Tracking events were usually done during the commute to the upper Sandy River for other work assignments, although some trips were strictly for the purpose of tracking the study fish. We were able to detect all tagged fish several times during the summer and fall and eight of the nine study fish were detected in the Sandy River as late as November 9th. Manual radio tracking has its limitations, but it was an effective technique in determining if the translocated adult ATS stayed in the Sandy River through spawning time.

The Sandy River valley has an extensive road network on both sides of the river. However, the river meanders between both sides of its valley and it became clear early in the tracking season that there was some roads that allowed for more efficient tag detection. There were some areas of the Sandy River that could only be effectively tracked from a specific side of the river. For example, the adult holding pool at Sandy River river km 94.40, which was a consistent site of detection for many fish, could only be effectively tracked by driving down the dead end Echo Valley Road on the northern side of the Sandy River. Areas like these were identified early in the tracking season, and manual radio tracking trips to the Sandy River became more efficient as the season progressed.

No tagged fish were ever detected in the Sandy River downstream of New Sharon. The Sandy River valley widens dramatically downstream of Farmington and the road network does not follow the river as tightly as it does upstream. Manual radio tracking efficiency is highly dependant on terrain. Radio tags have a highly variable detection range. Power and McCleave (1980) found that range is reduced dramatically by trees and other obstructions. Our experience supports these findings and would indicate a clear line of sight from the receiver to the transmitter increases this range dramatically. Also, the higher elevation the receiver is in relation to the tag, the better the signal detection. Power and McCleave (1980) estimated the range of their tags to be 0.8 to 1.4 km when tracking by boat, and 8.9 to 12.5 km when tracking by plane. The lack of success tracking fish in the lower portion of the Sandy River may be a product of tracking by vehicle. If it was deemed important to track tagged fish in the larger portions of the Sandy River below Farmington, it may necessitate the use of an airplane, helicopter or a boat.

Biological Observations:

Eight of the nine Atlantic salmon in our study displayed to some degree the same pattern of movement described by Hawkins and Smith (1986) and Heggberget et al. (1988). The study fish were observed to migrate in three distinct phases: rapid movement upstream for either long or short distances (following release into the Sandy River), a long residence period with little movement, followed by a short migration just prior to spawning. Based on the work of Dube (1988) and Power and McCleave (1980) the movements of the hatchery origin fish should be unpredictable and without pattern. Four of the study fish were of hatchery origin, yet only one of those fish, Evander, left the system or displayed random unpredictable movements. Perhaps the lack of dams and impoundments in the Sandy River, in contrast to the heavily impounded lower Penobscot River where the other studies were done, contributed to this behavior.

There were two pools that our study fish seemed to prefer for their long residence period. The study fish utilized the large pools at river km 99.10 and river km 94.40 throughout the summer months. (Figure 4.) This pool was also utilized by untagged ATS translocated to the Sandy River, as observed three occasions. It is unknown if these two pools were selected because of their physical characteristics, location in relation to spawning habitat, location near the release site at river km 97.67, or whether the translocated adults were displaying gregarious behavior. There are many pools within five river km's of the release site, and it is unknown why these two pools were chosen consistently by the majority of the translocated ATS. The only study fish not detected in these pools were Evander, who left the Sandy River 15 days after release, and Nyx. Nyx was detected to be in the pool at river km 87.13 first on September 7th, and was never detected anywhere else through January 31st, 2008. Nyx was visually confirmed by snorkeling to be alive at river km 87.13 on September 26th.

Translocation of ATS to the Sandy River to re-establish a population will be successful only if the translocated adults stay and spawn in the Sandy River. Jordan and Beland (1981) found that ATS in the downeast rivers of Maine commenced spawning at water temperatures of 7° to 10.5° C. and spawning was completed within seven to ten days. The temperature in the Sandy River fell into this range between October 22nd and November 1st (Figure 4.) and study fish Bellona was observed digging a redd in Saddleback Stream on October 24th. In this study, eight of the nine study fish were detected in the Sandy River on November 9th, when spawning for the season was likely completed. Manual radio tracking proved to be an effective method for determining if ATS translocated to the Sandy River from the Lockwood Facility fishlift on the Kennebec River in Waterville stay in the Sandy River through the spawning season.

This manual telemetry technique will be utilized for at least one more year to evaluate the management decision to translocate captured adult ATS to the Sandy River from the Lockwood fishlift on the Kennebec River. This project will also gather data about translocated adult ATS movement, river fidelity, migration patterns, differential movement of hatchery versus wild origin ATS, pool use, spawning timing and location, spawning duration, overwintering locations, downstream outmigration timing and patterns. In 2008, additional information will be gathered to better help managers evaluate the time needed to effectively track these translocated fish. Tracking efforts will be subdivided into different categories depending on the amount of effort for each tracking event, km's covered, whether the tracking was the only priority of the day, or whether it was secondary to other tasks. The data from this 2007 feasibility study will be pooled with adult tracking data in the Sandy River drainage. This robust dataset should better equip river managers to guide future adult release strategies and locations, stocking locations, electrofishing efforts, redd count surveys and future telemetry studies.

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Figure 1. 2007 Radio Telemetry Frequent Tracking Start and End Points.

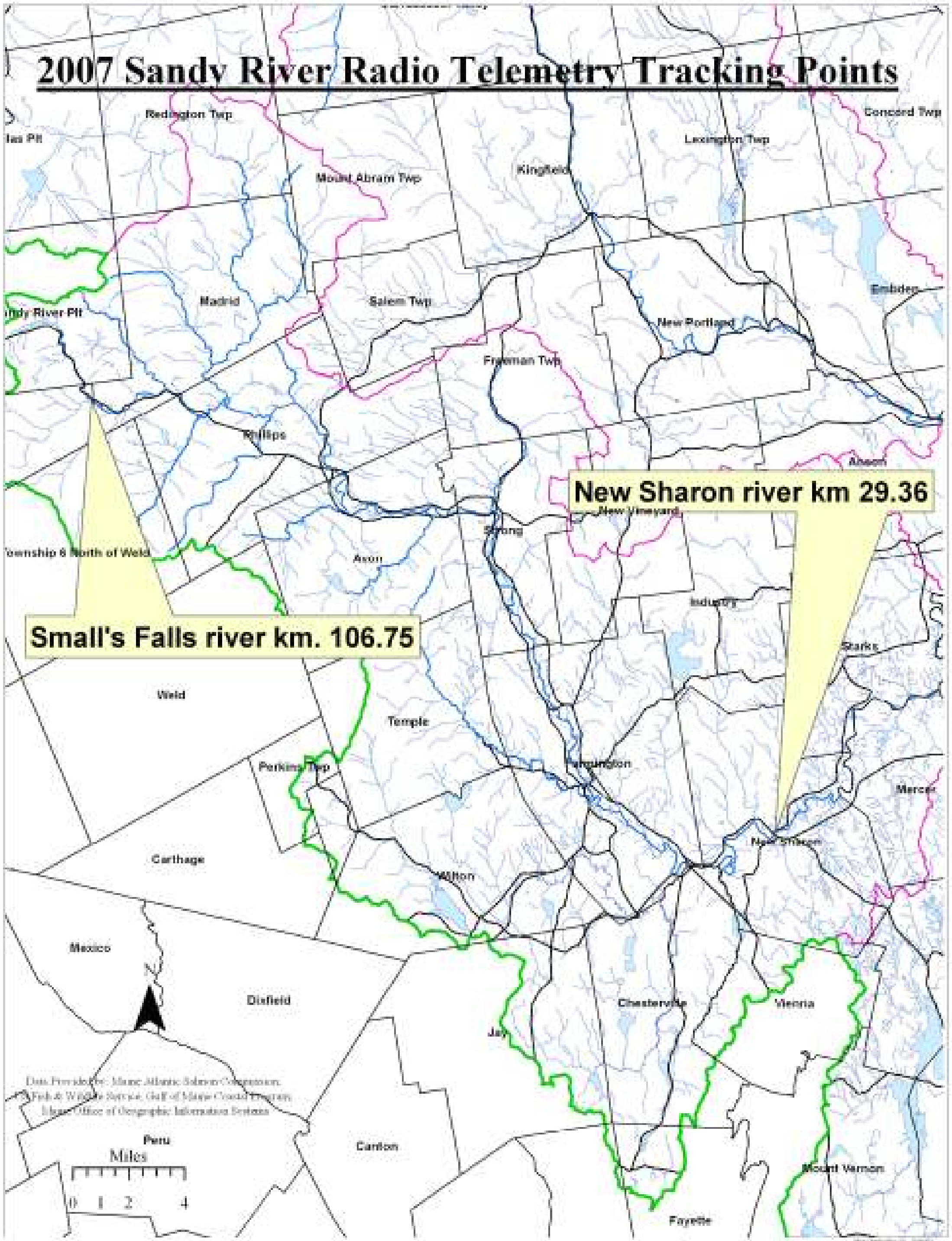
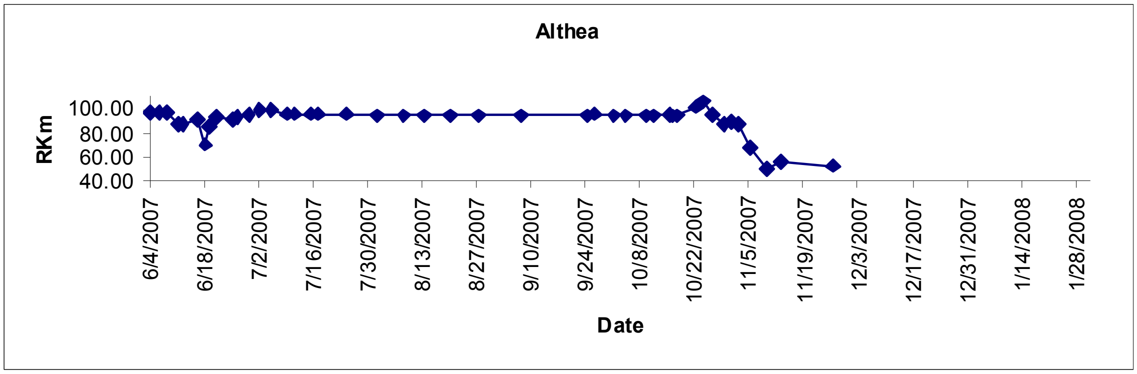
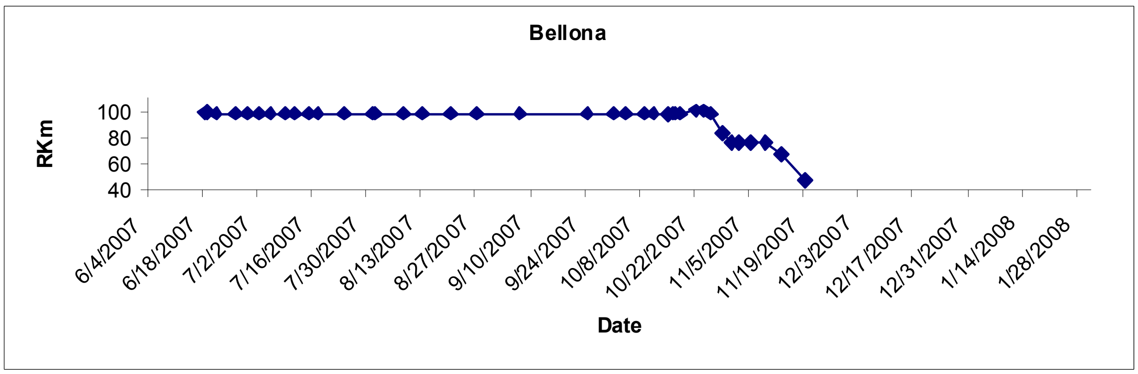
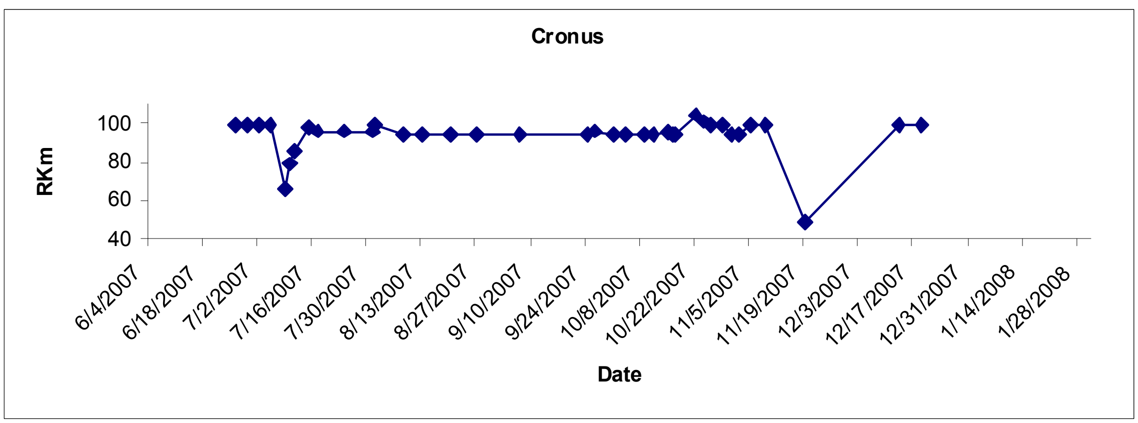
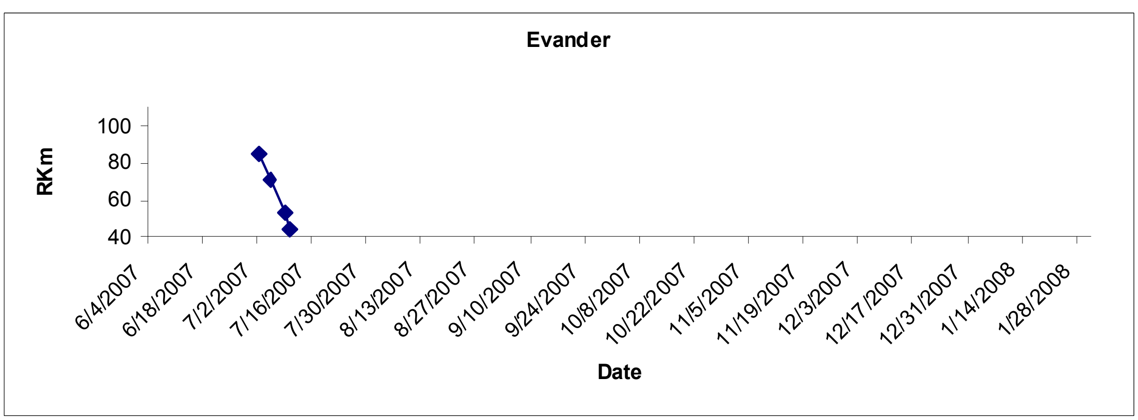


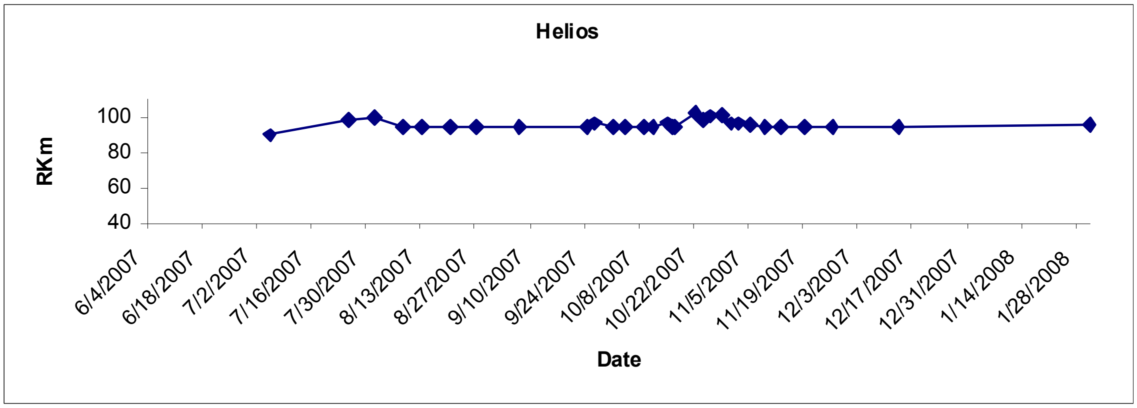
Figure 2. Individual Adult ATS Locations by Date







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9/10/2007
9/24/2007
10/8/2007
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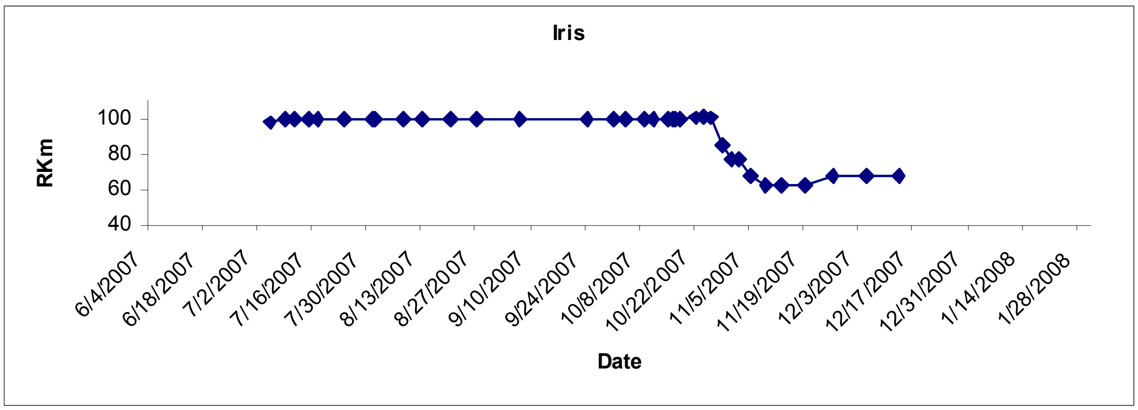
1/28/2008
Date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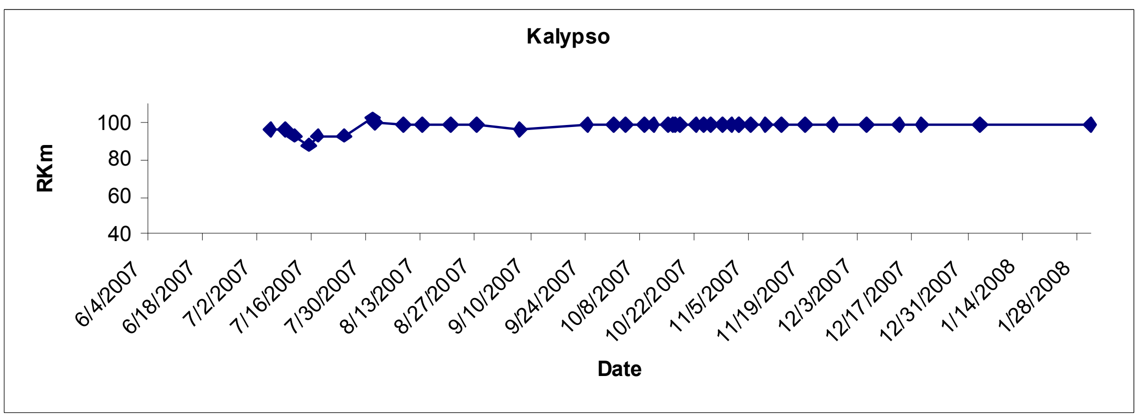
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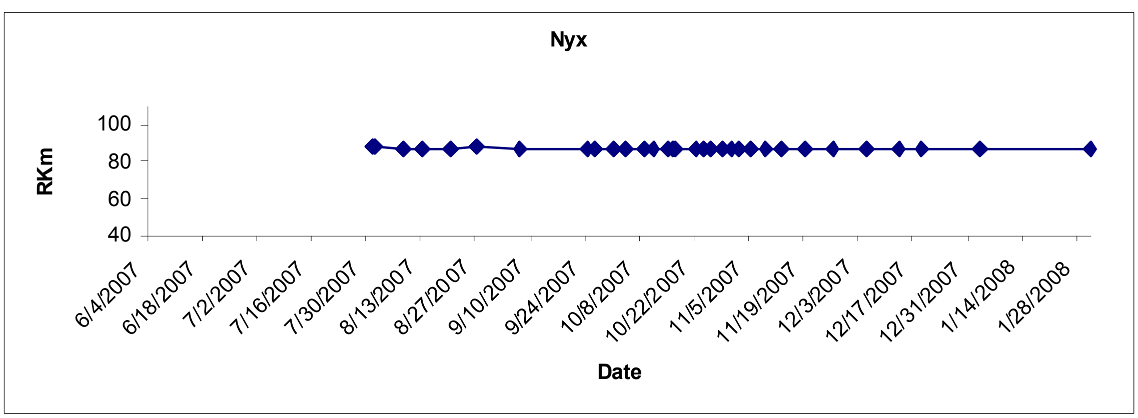
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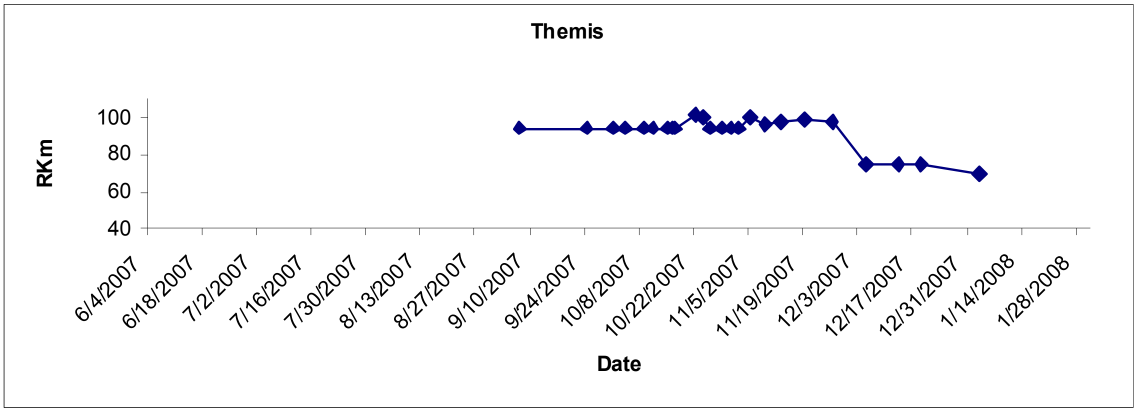
Date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10/22/2007
11/5/2007
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12/17/2007
12/31/2007
1/14/2008
1/28/2008
Date

Figure 3. 2007 Tag Detections for All Study ATS.

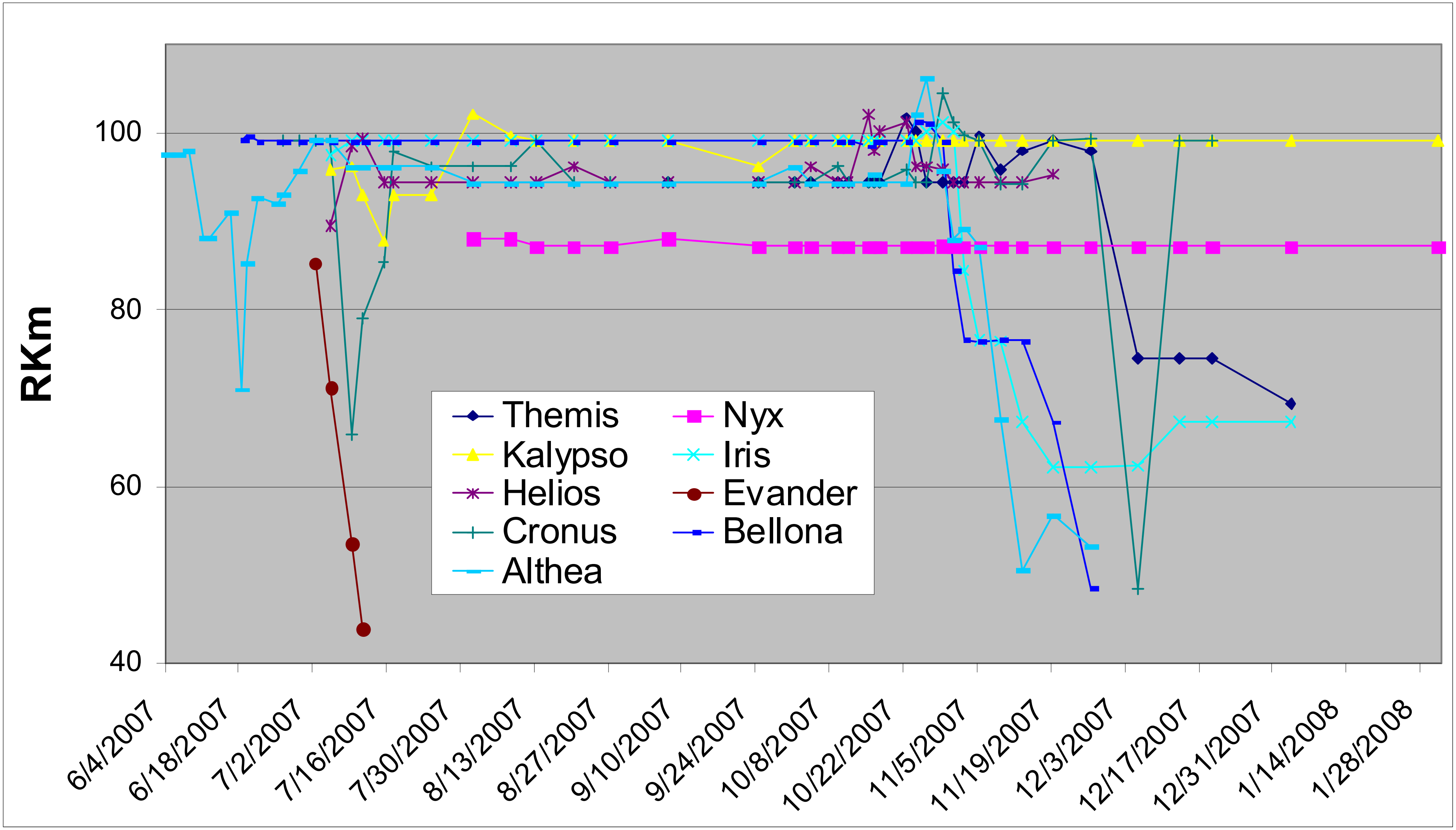
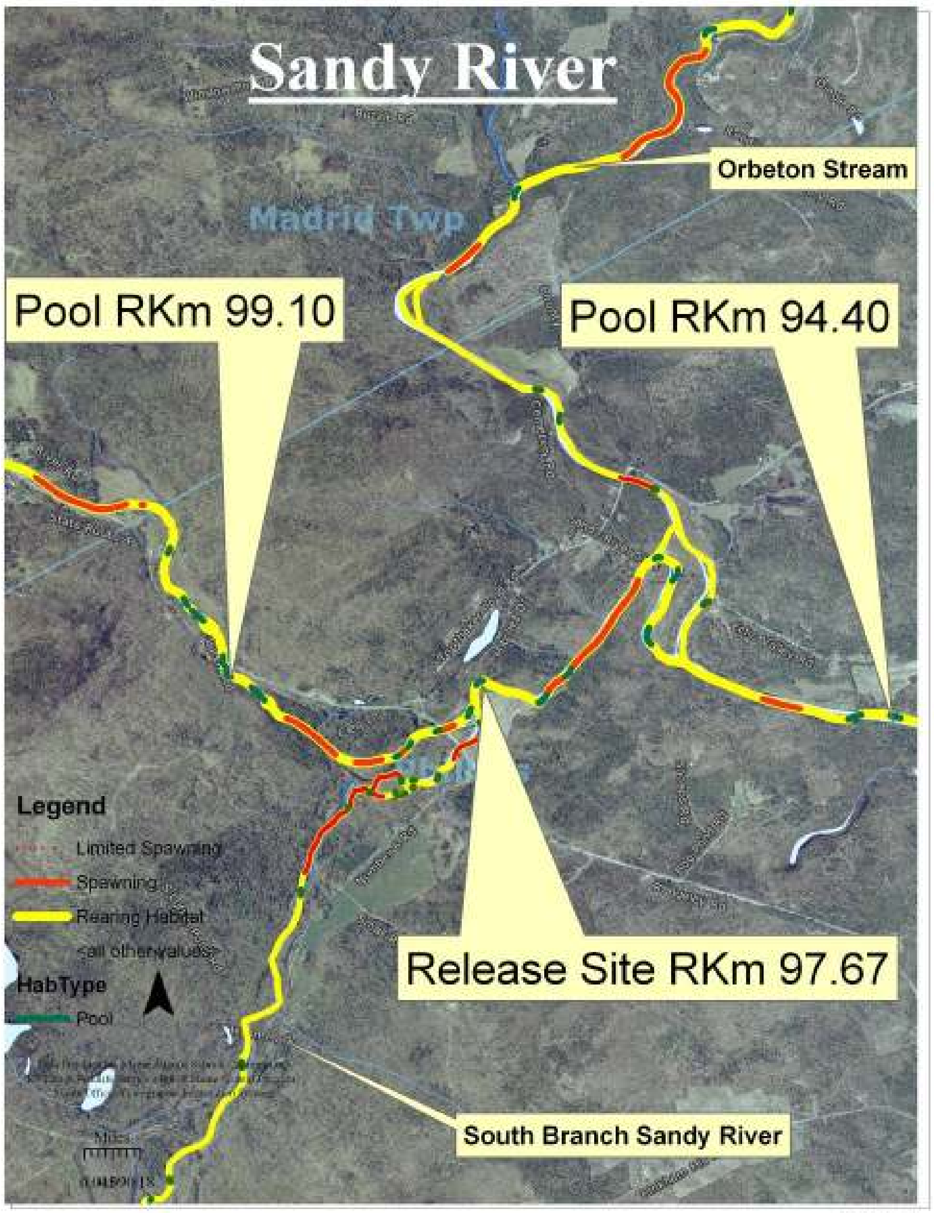


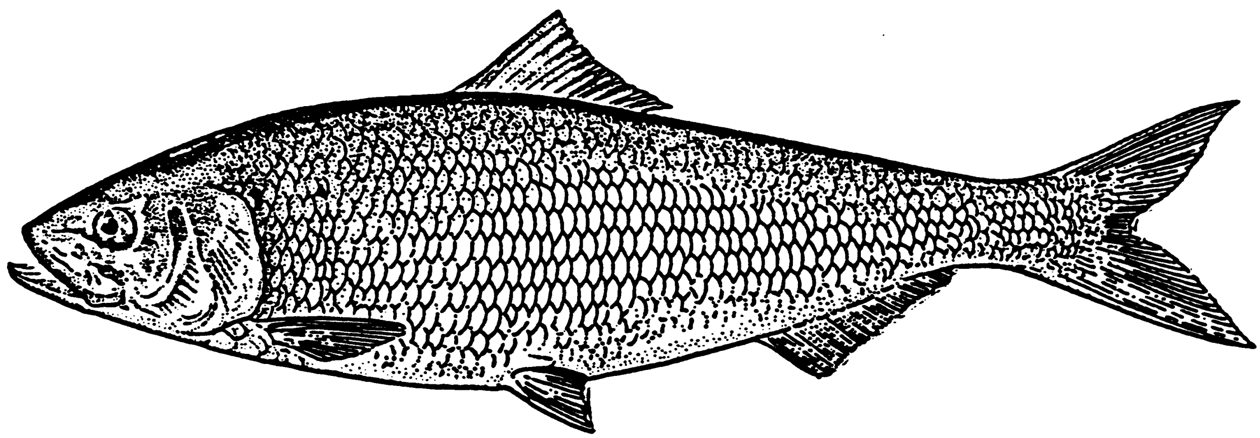
Figure 4. Extensively Used Adult Holding Pools in the Sandy River 2007.



APPENDIX G—

Waldoboro Shad Hatchery Report 2008

WALDOBORO SHAD HATCHERY



2008

Carolyn, Samuel and Andrew Chapman

ANNUAL REPORT

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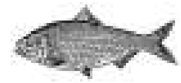
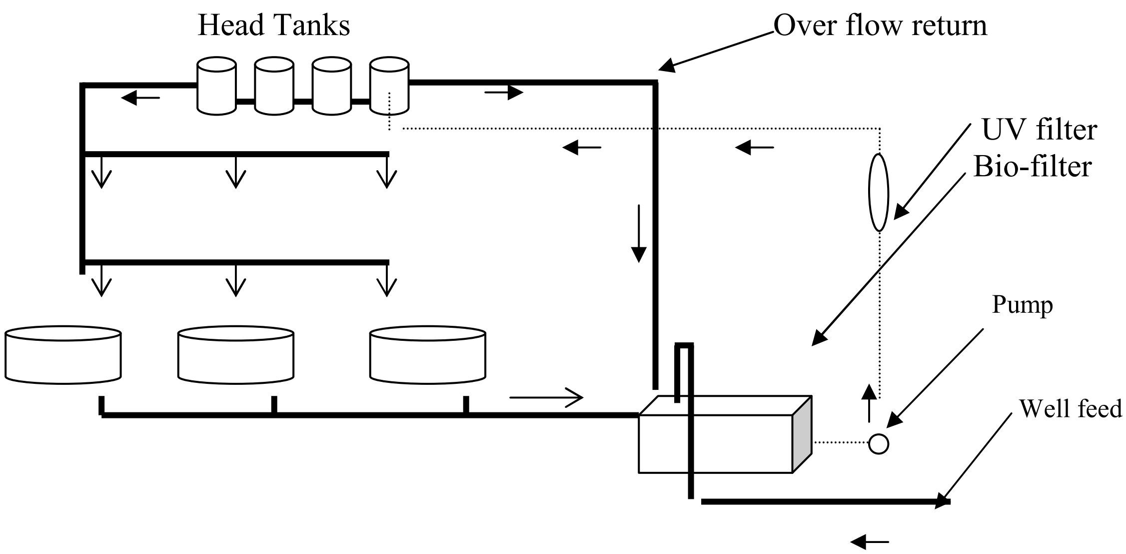


INTRODUCTION

In 1992, the Time and Tide Resource Conservation and Development Area Council, in cooperation with and financed by the Maine Department of Marine Resources, established a pilot shad hatchery in the town of Waldoboro, Maine. This operation was run in an 18' x 19' aluminum shed that had no running water. Water for the hatchery's operation was piped in from an artesian well overflow 325' from the site. Technology developed at the Susquehanna River Van Dyke Shad Hatchery proved to be very sound and reliable and was adopted for use at the Waldoboro Shad Hatchery.

BASIC HATCHERY CULTURE SYSTEM

Well water to the culture area comes through a raised head tank, a bank of four separate tanks, which provides constant low-pressure gravity fed water through a 2" PVC pipe system.



DETAILED SYSTEM INFORMATION

Water coming into the building goes through a 50-micron filter and UV sterilizer before entering the head tank. The tank is built on a shelf close to the ceiling to provide water pressure and some height for the pipes above the culture tanks. Excess flow to the head tanks is allowed to return to a bio-filter recirculation tank where it is mixed with new water coming into the building, heated, aerated, and pumped back up into the head tanks. Seven 6' diameter x 3' deep fiberglass tanks were constructed locally and are positioned under the pipe system in a floor plan that allows easy access for culture and cleaning. Plastic upwelling incubators sit on tables beside the tanks. Newly hatched fry swim up to the top of the incubators and are automatically drained into the fry culture tanks; they are held in the tanks 5-7 days after hatching. Brine shrimp are the primary fry diet and a system to conveniently provide feed to all the tanks is required. Four fiberglass 125-

gallon, conical bottom tanks were set up to supply the hatched brine shrimp for the fry. Two 250-gallon fiberglass tank holds a day's supply of brine shrimp and is connected to two systems of pipes, valves, and timers that automatically feed a plentiful diet of newly hatched shrimp over a 22-hour period to all the culture tanks at once. The fiberglass tanks used to culture the fry are 6' in diameter and 3' deep, with a slight slope to the center drain. This drain is a threaded 2" fitting that is designed to accept a 2" standpipe, which in turn maintains the tank water level. All water flow out of the fry culture tanks is filtered and piped into the outflow end of the head tank bio-filter recirculation system. If a water crisis should develop, the larval culture tanks can be put into a temporary recirculation loop through the bio-filter tank with no stress to the fish in the tanks.

Tank effluent normally drains to a nearby pond, but the drain arrangement may be changed by opening and closing a series of valves in order to allow fry ready to be stocked to drain directly into the stocking tank on the bed of a ¾ -ton pickup.

In 2007 a 12,000 gallon storage tank was added to the water feed system. This capacity give the hatchery 6-7 hours of reaction time to any catastrophic water feed challenge. Also in 2007 a second well was put online as another hedge against water feed challenges.

TANK SPAWNING SETUP

The system consists of one 12' and two 15' diameter x 4' deep adult shad holding tanks that gravity drain into separate 3'x 3' x 8' bio-filter tanks from which treated water is pumped back into the spawning tanks at a rate of approximately 30 gallons per minute. Depending upon its size, each round spawning tank receives 5-7.5 gallons of new water per minute. Each bio-filter tank is now fitted with three 3000-watt stainless steel immersion heaters, each set of which provides as much heating capacity as a standard 30,000 BTU, 40-gallon home hot water heater. The previous use of 4000-watt immersion heaters was an under-sized heating capacity for maintaining optimal tank spawning temperatures early in the season. Each bio-filter tank has had its degassing capabilities augmented with the addition of aeration towers with extra surface-to-water enhancing media.

Because shad eggs sink, the spawning tank has to drain from the center bottom. To accomplish this, an 8" plastic collar is placed around the 4" overflow. This collar causes the water to drain from the center bottom of the tank, carrying along with it any eggs that naturally drift to the center. Water coming from the spawning tank enters the bio-filter tank through a 3" pipe tee that is drilled with ¾" holes and acts as a muffler in slowing down the water velocity and evenly diffusing water currents. Knitted polyethylene bags of 0.5mm mesh are tied onto both legs of the water muffler to collect eggs released by adult shad; the bags are changed each morning and the collected eggs placed in incubators.

TANK SPAWNING SYSTEM

The system was operated in the same manner as that described in the 1999 report. The eggs from the tank spawning systems were produced without the use of hormones.

BROODSTOCK:

Broodstock adult shad transported to the hatchery by truck can exhibit obvious bruising about the head and inside the eyes, as well as severe scale loss. Any incoming shad that exhibit bruising about the head are either DOA or die soon after being transferred to the spawning tank. In addition to the bruised and traumatized shad, there is a significant percentage that are lightly battered and descaled. These shad soon become festooned with heavy patches of fungus and eventually die. Careful selection by the transport crew of only vigorous and blemish-free fish has shown to have a dramatic positive effect on the overall survival of the transported shad.

During the 2008 season shad broodstock were obtained from the Merrimack River. Between May 30 and June 15, 614 adult shad were transported from Lawrence, MA to Waldoboro and were received in very good condition. There was a total of 6 shad mortalities during the transportation of the 614 adult shad to the hatchery. At the end of the season, 299 surviving shad were returned to the wild in the upper end of the Medomak River estuary.

EGG VIABILITY

It has been noticed that some batches of eggs exhibit low viability due to the presence of small immature eggs. These eggs contribute to nutrient loading and the promotion of fungal growth in the egg incubators that would be lessened if the small eggs were removed. Since 1998, all eggs delivered to or produced at the hatchery are sieved on a variety of mesh sizes. Past investigation has revealed that most eggs <2mm are not viable. Generally, only the eggs that are retained on a 2mm screen are selected for incubation.

In 2008 egg volumes were measured as they came into the hatchery. Dead white eggs were immediately removed and their volume subtracted. At 24-30 hours into incubation more dead white eggs were removed, the number of eggs enumerated and a viability determined. The change in technique for 2008 was an attempt to inhibit fungal development associated with dead eggs.

ENUMERATION OF CULTURE TANK MORTALITY

During the hatchery season, waste that is routinely siphoned from the bottom of the culture tanks is sampled to determine larval mortality after hatching and up to the time of stocking. Individual tanks were/are not cleaned daily. It takes several days for detritus to develop and show on a tank bottom; there-fore, the cleaning time interval varies from one batch of larvae to the next. When a tank is cleaned, the bottom waste is siphoned into several plastic buckets and diluted to 15 liters per bucket; the contents are suspended by mixing with an open hand. While a bucket is being mixed, three 10-ml samples are removed and emptied into three individual petri dishes. The live and dead larvae are counted separately, but both are counted as mortality. An average of the three samples, including live and dead larvae, are determined as larvae mortality per milliliter. The number of mortalities per bucket is estimated by multiplying the average of the three samples by 15,000. Finally, total mortality is estimated as the sum of the means of all the buckets. Mortalities were determined for all batches of cultured shad and are listed as “Fry discarded” in the data table 1. The number of fry discarded increases with amount of time they are maintained in the hatchery system.

HATCHERY PRODUCTION SUMMARY FOR 2008

Waldoboro Hatchery Tank Spawning System:

A total of 614 Merrimack River shad were delivered to the Waldoboro Shad Hatchery between May 30 and June 15. While in the hatchery system the Merrimack River shad produced a total of 4,807,030 viable eggs were produced. Viability averaged 91.27%. This % viability figure is now meaningless for determining incoming egg batch general condition as all the dead eggs are now removed before any eggs per volume or viability enumeration takes place. During culture, 565,810 dead shad fry were removed and discarded. A total of 3,283,136 fry were stocked directly into the Kennebec River, 712,286 fry were stocked into the Androscoggin River and both rivers received a double OTC mark. There were 288,507 fry stocked into the Kennebec River below the Lockwood Project that received a triple OTC mark. A total of 4,283,929 shad fry were marked and released from the Waldoboro Shad hatchery in 2008. The percent success of the OTC marking process has not yet been verified.

Fry Stocking Summary:
See table 1 attached at the end of this report.

Tank Mortality

As the season progressed the hatchery began to experience abnormal fry mortality that appeared to be associated the marking process. Fry were sampled and sent to the University of Maine Fish Health Diagnostic Laboratory and the testing results were negative for bacterial infections and inconclusive for the cause of the mortality being the OTC marking process. It was a thought proposed that there may have been a change in the formulation of the OTC in a different brand introduced mid-way into the season. In our next season we will utilize a brand of OTC that we have not had any recognizable adverse affects from.

POND CULTURE

There were no fry cultured in any ponds in 2008. It is surmised that the opening of the water drain in early spring during an exceptional rainfall allowed fat head minnow adults to enter the pond the fry normally escape into and fed on any fry as they entered the pond. No shad fry feeding activity was observed in the pond as the season progressed and the cormorants that normally are a problem in the shad fry pond were not frequenting it though they were often seen in the lower ponds. No fall seining was attempted.

RECOMMENDATIONS FOR 2008

When adult shad were sampled for USGS requirements at the end of the spawning season it was noted that there was a noticeable number of ripe females that had not spawned and that all the males sampled were spent. This supports the line of thinking that after the systems are filled initially; there should be a weekly addition of fresh adults to maintain a vigorous spawning activity in the tanks. This additional replenishment could come from either the Merrimack or Kennebec Rivers. A decision needs to be made to include this replenishment of adults in shad transportation scheduling and made a normal part of the transport personnel scheduling.

It needs to be said also that the DMR transport activities were short circuited due to priority demands on adult shad at the Lawrence lift imposed by the USF&W in 2008. Better coordination and communication between USF&W and MEDMR, at that time, quite possible might have resulted in higher production numbers at the Waldoboro Shad hatchery. Solutions to possible scheduling conflicts should be discussed and a workable protocol developed with a M.O.U. between agencies and states during some pre season time.

					2008 EGG AND FRY PRODUCTION									
Date	Source	Fry tank	Incubator	Volume eggs mls	Total eggs >2mm	% viability	Viable eggs >2mm	Fry started	Fry end	Fry discard	Marked	Fry stocked	Date stocked	Stocking location
3-Jun	Merr	1	1	1140	68444	97.5	66733	8-Jun						
4-Jun	Merr	1	2	1302	63683	93	59225	9-Jun						
5-Jun	Merr	1	3	629	34731	82.6	28688	9-Jun						
6-Jun	Merr	1	4	1189	73444	80	58756	10-Jun						
7-Jun	Merr	1	5	759	54274	91.8	49823	10-Jun						
8-Jun	Merr	1	6	1141	61299	96.7	59276	10-Jun						
9-Jun	Merr	1	7	695	41727	74.4	31045	11-Jun	12-Jun	6010	6.15.18	347536	23-Jun	Kenn
10-Jun	Merr	2	8	3971	259846	93	241657	12-Jun						
11-Jun		2	9	6515	391154	93	363773	13-Jun						
12-Jun	Merr	2	10	4110	268942	97	260874	15-Jun	17-Jun	20600	6.19.22	845704	25-Jun	Kenn
13-Jun	Merr	3	11	6250	418100	95	397195	17-Jun						
14-Jun	Merr	3	12	5485	33808	93	315091		19-Jun	0	6.21.23	712286		Andro
15-Jun	Merr	4	13	6345	424455	96	407477	18-Jun						
16-Jun	Merr	4	14	1867	124895	94	117401	19-Jun						
17-Jun	Merr	4	15	404	24955	69	17219	21-Jun						
18-Jun	Merr	4	16	3025	174146	96	167180	21-Jun	22-Jun	1500	6.24.27	745002		Kenn
19-Jun	Merr	5	17	2186	156314	93.7	146466	23-Jun						
20-Jun	Merr	5	18	4375	292670	96	280963	24-Jun						
21-Jun	Merr	5	19	4877	348740	97	338278	24-Jun	25-Jun	72500	6.28.7.1	693207		Kenn
22-Jun	Merr	6	20	2678	170240	97	165133	26-Jun						
23-Jun	Merr	6	21	2067	135256	98	132551	27-Jun						
24-Jun	Merr	6	22	2142	136167	97	132082	26-Jun						
25-Jun	Merr	6	23	2024	144730	98	141835							
26-Jun	Merr	6	24	2434	174048	96	167086		1-Jul	87000	7.03.06	651687		Kenn
27-Jun	Merr	7	25	2063	143180	99	141748	30-Jun						
28-Jun	Merr	7	26	1372	104239	98	102154							
29-Jun	Merr	7	27	1875	142455	98	139606							
30-Jun	Merr	N/A												
1-Jul	Merr	7	28	850	56862	90	51176	5-Jul						
2-Jul	Merr	7	29	964	74953	93	69706	6-Jul	6-Jul	306500	7.9.12.15	203374		Sebast
3-Jul	Merr	N/A												
4-Jul	Merr	8	30	1184	89956	98	88157	7-Jul						
5-Jul	Merr	8	31	608	49140	35	17199							
6-Jul		N/A												
7-Jul		N/A												
8-Jul	Merr	8	32	810	54186	95	51477	10-Jul	11-Jul	71700	7.15.18.21	85133		Sebast
												4283929		